AMT-18 Cruise Report

RRS James Clark Ross JR218

(3rd October – 10th November 2008)

Principal Scientist : Malcolm Woodward

Plymouth Marine Laboratory

PML | Plymouth Marine Laboratory

Oceans 2025

National Oceanography Centre, Southampton
University of Southampton and Natural Environment Research Council

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Prepared and edited by:
Malcolm Woodward, Principal Scientist: AMT-18,

Plymouth Marine Laboratory
Prospect Place
Plymouth
Devon
PL1 3DH
England

m.woodward@pml.ac.uk
01752 633459 (office): 01752 633100 (switchboard)

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Abstract

This was the eighteenth in the series of Atlantic Meridional Transect (AMT) cruises, and was carried out on board the British Antarctic Survey research vessel the RRS James Clark Ross.

The cruise sailed from Immingham in the United Kingdom on 4th October 2008, and ended in Port Stanley, The Falkland Islands, on November 10th, 2008.

This is the first of a new series of AMT cruises funded through Theme 10b of the NERC OCEANS 2025 science programme, which is a scientific collaboration between Plymouth Marine Laboratory (PML) and the National Oceanography Centre, Southampton (NOC,S).

This is now the third phase of the AMT with the first 11 cruises between 1995 and 2000, funded by PML, NERC and NASA. Phase 2 was between 2002 and 2005 and was funded by a NERC consortium grant with many institutions from around the UK contributing to the scientific aims, and this was led by Carol Robinson at PML.

The AMT-18 Participants were an International team gathered from PML, NOC, University of Warwick, Bigelow Laboratory of Ocean Sciences, USA, University of Newcastle, The Natural History Museum London, The British Antarctic Survey, and the Universidad de la Republica, Montevideo, Uruguay.

AMT Aims

Strategic Aims:
The Atlantic Meridional Transect programme (AMT; www.amt-uk.org) will provide a sustained open ocean ***in situ*** observing system to enable early warning of any fundamental change in ecosystem functioning and to better forecast the marine environment for society's needs. AMT will also provide a contextual logistical and scientific infrastructure for independently funded national and international open ocean biogeochemical and ecological research.

AMT addresses some of the strategic research questions prioritised by NERC (Science for a Sustainable Future) including those related to carbon cycling and the diversity of microbial assemblages and their role in ecosystem function. AMT also contributes to three themes within Defra's Science and Innovation Strategy: climate change, conservation, and the marine environment. In particular, AMT provides a means to assess biodiversity trends in relation to environmental change, to improve understanding of the structure and functioning of marine ecosystems including the interactions between physical and ecological processes and the impact of climate change on the ocean.

Overall Aims and purpose:
The biota of the surface ocean has a profound influence on the global budgets of climatically-active trace constituents in the atmosphere, and hence, climate, while atmospheric deposition of nutrients and changes in weather patterns affect the diversity and activity of marine plankton (Gnanadesikan et al., 2003; Sarmiento et al., 2004). In order to reduce uncertainties in the prediction of the future global environment an improved knowledge of the interactions between marine and atmospheric biogeochemical cycling is required. AMT (Aiken and Bale, 2000; Aiken et al., 2000; Robinson et al., 2009) is a time series of stations along a 13,500 km transect in the Atlantic Ocean. The overall aims of AMT are to quantify the nature and causes of ecological and biogeochemical variability in planktonic ecosystems, and to assess the effects of this variability on biogenic export and on air-sea exchange of radiatively active gases. Eighteen cruises have been completed so far, and the data collected have contributed to over 115 peer reviewed publications and 68 PhD theses. (http://www.pml.ac.uk/amt/publications/amt_publications.html).

This sustained observing system aims to provide basin-scale understanding of the distribution of planktonic communities, their nutrient turnover and biogenic export in the context of hydrographic and biogeochemical provinces. The spatial and interannual

variability in the air-sea exchange of climatically important microbiologically mediated gases (e.g. carbon dioxide, oxygen, dimethylsulphide) is influenced in part by the composition of the plankton community and the relative magnitude of photosynthesis (P) and respiration (R). The balance between P and R (=net community production NCP) is poorly constrained, with measurements disagreeing on the sign let alone the magnitude (Williams, 1998; Duarte et al., 2001). Dissolved organic matter (DOM) is an important sink of organic carbon in pelagic ecosystems which can be decomposed in surface waters by both heterotrophic bacteria and short-wave solar radiation. The spatial and temporal extent of this has been well characterised in coastal waters (Smith & Benner 2005) but remains poorly studied in oceanic environments. AMT enables the measurement of P, R, NCP, plankton community structure, nutrient turnover, CO2, O2, and DOM photodegradation over large spatial scales and seasonal, interannual and decadal time scales to better define natural variability and long term trends. AMT will be scientifically led and co-ordinated at PML following the successful management and co-ordination strategy (including stakeholder participation) applied over the past 10 years (http://www.pml.ac.uk/amt/publications/SMA_review.pdf).

Description of Activities

Core measurements AMT (2008-2012) will include five transects between the UK and the Falkland Islands collecting core hydrographic, chemical, ecological and optical data. Many of these measurements will be made in underway mode (either via towed instruments or those connected to a non-toxic surface seawater supply onboard) with minimum personnel intervention. However depth profiles of CTD and water samples will also be taken at daily pre-dawn and mid-morning stations to normally a maximum of 300m, but with full ocean depth sampling as required by the specific scientific questions on the different cruises. The physical environment will be characterised using vessel mounted ADCP and towed undulating profiler (MVP, Moving Vessel Profiler) data. Boundaries between upper ocean water masses, edges of eddies and unstable fronts, will be determined by the position of current jets and compared with near real-time satellite images and upper ocean density sections.

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Acknowledgements and Thanks

Very many thanks to Captain Jerry Burgan and his deck officers, Tim, Gareth and Alex for driving a straight course, despite the vagaries of the scientific programme, and also to Mike for looking after and helping us with our communication issues along the way.

Also to the fine team of well oiled engineers for keeping everything running, even with the couple of heart, equipment, and ship stopping moments which were dealt with without too much effect on the science.

Thanks to Rif, Lee and Shaky for impeccable steward service as always, plus the best cheese board in the nautical world. Thanks to the entire catering department marshalled by Richard our Purser, who produced some excellent food.

As always thanks to 'Doug the Deck' for all his help and back-up to the science activities, and for repeatedly demonstrating his great love and dedication towards the underway pCo2 system. And finally thanks to all the deck crew led by Dave without whom it would be impossible to do anything over the side.

Sadly at the start of the trip we lost Mark Preston from the cruise, which was a possible show stopper as far as the AMT science was concerned, where the CTD operations are paramount. However we were lucky to have 2 fine NMF boys with us in Terry and Dave who took on the extra responsibilities for running the CTD operations and apologies for some of the complicated bottle firing patterns that we set up early in the mornings. Here also thanks to Bruce for policing Terry in order to stop him firing a bottle at 500metres at the pre-dawn CTD each morning whilst he was still trying to wake up!

Not content with that they also kept the liquid nitrogen generator running and more importantly got a very good and valuable data set out of the MVP, and it was at last gratifying to see it start to produce the data sets that we always hoped it would. I believe this cruise has produced more data than all the other deployments it has ever done, added together. So, very many thanks to Terry and Dave for their excellent support.

Many thanks to Ben Tullis who kept the computer systems running and also did a fabulous job in jury rigging the liquid scintillation counter and getting it to work again right at the start of the cruise, and then last but not least thanks to Nerys our fine Doctor and for looking after our medical needs, particularly with repeatedly caring for one of our scientists who was particularly injury prone!

We should not forget all the help and advice from both the BAS Logistics team in Cambridge, particularly Julia Fear, Chris Hindley and Kath Nicholson. Also thanks to the NMF operations and NMFSS teams at Southampton for all their support in getting this AMT cruise operational.

Back at PML I thank greatly Julia Crocker for all her help with wise counselling, and with sorting out the logistics paperwork mountain!

Thanks finally to all the AMT science team for making this an enjoyable and very rewarding cruise and the teamwork of all the scientists pulling together has been excellent. The team spirit was great to be a part of, particularly considering the disparate group of people who started the cruise hardly knowing each other. You have made the PSO job a pleasure so thank you all, those of you who are returning on future AMT's then I and the AMT programme look forward to sailing with you again.

Cruise participants

As well as the usual eclectic mix of people and host scientific institutions as is normally the case for an AMT cruise. Complimenting the core science and support teams we were joined by a small team from BAS who were investigating the co-ordinated operations of all the ships acoustic systems. They stayed with us from Immingham until The Azores. We also had John Allen with us who was there in a training capacity for the NOC physics team, and he too left in the Azores.

Scientific personnel

AMT Team	Institute	Role
Malcolm Woodward	PML	Principal Scientist AMT, nanomolar ammonium
Carolyn Harris	PML	Micro-nutrients
Vas Kitidis	PML	Oxygen production and Respiration.
Gavin Tilstone	PML	Primary production and photo-oxidation of coloured dissolved organic material (CDOM)
Glen Tarran	PML	Flow Cytometry
Chris Gallienne	PML	Optics and zooplankton netting
Stuart Painter	NOC	Ocean Physics
Jo Hopkins	NOC	Ocean Physics
Ross Holland	NOC	Microbial plankton community abundance, structure and dynamics
Manuela Hartmann	NOC	Microbial plankton community abundance, structure and dynamics
Mike Zubkov	NOC	Microbial plankton community abundance, structure and dynamics
Bruce Bowler	Big	AMT 18 Bio-Optics and remote sensing
Martin Ostrowski	UWar	Factors Affecting Community Structure of Marine Picocyanobacteria
John Pearman	UWar	Factors Affecting Community Structure of Marine Picocyanobacteria
Martine Couapel	NHM	Coccolithophore biogeography
Jeremy Young	NHM	Coccolithophore biogeography
Paul Mann	UNew	Ammonium photoproduction
Mario Vera Sierra (Mario Vera)	Urug	SCOR-POGO student
Immingham to Azores only		
Peter Enderlein	BAS	Acoustic trials
Sophie Fielding	BAS	Acoustic trials
Alex Tate	BAS	Acoustic trials
Huw Venables	BAS	Acoustic trials
John Allen	NOC,S	Ocean Physics
BAS scientific support		
Ben Tullis	BAS	IT Support
NMF-SS technical support		
Terry Edwards	NOC, NMF-SS	CTD/MVP/Liquid N
Dave Teare	NOC, NMF-SS	CTD/MVP/Liquid N

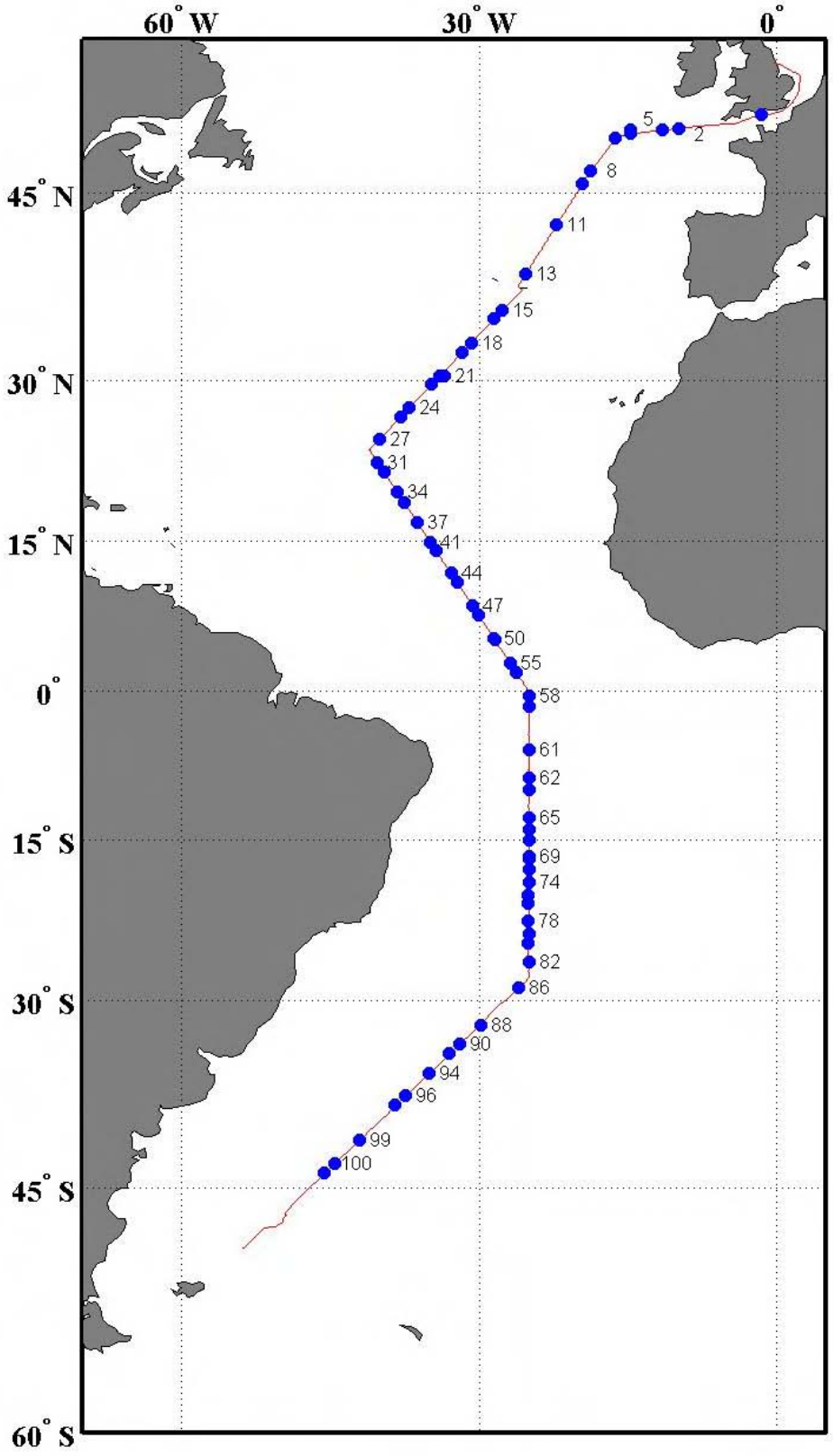
Key

PML: Plymouth Marine Laboratory, Prospect Place, Plymouth, PL1 3DH, UK
NOC: National Oceanography Centre, European Way, Empress Dock, Southampton, SO14 3ZH, UK
BAS: British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET, UK
UWar: University of Warwick,
UNew: University of Newcastle, Newcastle, NE1 7RU, UK
NHM: Natural History Museum, Palaeontology Department, London SW7 5BD
Urug: Universidad de la Republica, Montevideo, Uruguay.
Big: Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, ME 04575 USA

Ship's personnel

Name:	Rank/Rating:
Jerry Burgan	Master
Timothy Page	Chief Officer
Gareth Bonner	Second Officer
Alexander Spooner	Third Officer
Michael Gloistein	ETO (Comms)
Duncan Anderson	Chief Engineer
Thomas Elliott	Second Engineer
James Stevenson	Third Engineer
Ralph Tulloch	Fourth Engineer
Douglas Trevett	Deck Engineer
Richard Turner	Catering Officer
Nerys Lewis	Doctor
Dave Peck	Bosun
Albert Bowen	Seaman
Kelvin Chappell	Seaman
George Dale	Seaman
Kevin Holmes	Seaman
Ian Raper	Seaman
Timothy Patterson	Seaman
Robert Hart	Motorman
Gareth Wale	Motorman
Ashley Huntley	Chief Cook
Jamie Lee	Second Cook
Graham Raworth	Steward
Nicholas Greenwood	Steward
Lee Jones	Steward
Michael Weirs	Steward

AMT-18: Actual Cruise Track with CTD stations



JR218: AMT 18 (OCEANS 2025) cruise track

Waypoints:

1. E1 Site off Plymouth (optional): ($50^0$02'N $04^0$22'W)
2. PAP site: ($49^0$00N $16^0$30' W)
3. NAG site: ($23^0$46'N $41^0$06' W)
4. Equator: ($00^0$00'S $25^0$00' W)
5. SAG site: ($18^0$31'S $25^0$06'W)
5. Southern turn: ($28^0$00'S $25^0$00' W)
6. Port Stanley: Cruise end

Cruise Sampling Stations and Science Activities

Science activities compiled by Captain M.J.S.Burgan and PSO Malcolm Woodward

Mobilisation commenced 30th September 2008, one day earlier than planned during cargo loading. Had this not been possible, departure from Immingham would have been delayed

STATION	DATE	POSITION	TIME (LOCAL)	COMMENTS
**Mobilisation Time	30/09 to 03/10/08	Immingham		2 ½ days required to prepare Science equipment for sea
				Departed Immingham 1020 03/10/08, cleared River Humber approaches 1220 BST
AMT18-CTD 001	04/10/08	50°24'N 001°31'W English Channel	1358-1530	SW7-8. Rough Sea, mod swell. CTD & MVP trial deployment, 20m: OK
AMT18-CTD 002 and 003	06/10/08	49°28'N 009°51'W	0425-0710	SW3/4. CTD134m (x2)
AMT18-CTD_004	06/10/08	49°22'N 011°33'W	1242-1410	SW4. CTD 500m, Optics rig 180m
JR218 Acoustic Trials	06/10/08			BAS Trials of EM120 etc over shelf-break required reversal of track between 200m and 1000m contour, adding 42 nm distance to passage, and (incl XBTx3)
AMT18-Assessment	07/10/08	49°09'N 014°33'W	0342-0350	WNW6-7. Mod/rough sea. Stopped to assess Wx for sation
AMT18-CTD_005 and 006	07/10/08	49°09'N 014°40'W	0405-0658	WNW6-7Mod/rough sea. CTD300m + 500m Bongo Nets 175m
AMT18-CTD_007	07/10/08	48°53'N 016°10'W	1219-1420	NW6. Mod/rough sea. CTD 500m Optics rig 180m
AMT18-CTD_008 and 009	08/10/08	46°35'N 018°41'W	0405-0730	NW3. CTD 300m + 500m Bongo Nets 175m
MVP Tow [1]	08/10/08		0730-1216	MVP Deployed – took over 40 mins MVP Recovered: Bridle deformed
AMT18-CTD_010	08/10/08	45°40'N 019°35'W	1216-1345	SW3-4. CTD 300m Optics Rig 180m
AMT18-CTD_011 and 012	09/10/08	45°08'N 020°04'W	0405-0636	SSW4. CTD 300m + 500m Bongo Nets 180m
AZORES	09/10/08	40°58'N 023°37'W	1507L / 1607z	Entered Azores EEZ
AMT18-CTD_013 and 014	10/10/08	38°53'N 025°19'W	0405-0645	Var 2. CTD 300m +500m Bongo Nets 180m
AZORES	10/10/08	Ponta Delgada	1500-1528	Boat Transfer of 1 x NOC (John ALLEN) + 4 x BAS Personnel
AMT18-CTD-015 and 016	11/10/08	36°01'N 027°44'W	0405-0705	SW3. CTD 300m + 500m Bongo Nets 180m MVP deployed: 11.5 kts Max through water required
MVP Tow [2]	11/10/08	Passage @ reduced speed: MVP request.	0705-1215	MVP tow speed of 11.5 kt through water gave only 10.26 kts over ground
AMT18-CTD_017	11/10/08	35°19'N 028°28'W	1215-1347	MVP recovered. CTD 300m F'deck Nets 180m Optics Rig 180m

AZORES	11/10/08	35°05'N 028°40'W	1520L / 1620z	Departed Azores EEZ. BAS Passage Speed Required = 11.70 Kts
AMT18-CTD_018 and 019	12/10/08	33°18'N 030°48'W	0405-0640	SW3. CTD 300m + 500m Bongo Nets 180m x 2
AMT1CTD_020	12/10/08	32°29'N 031°43'W	1218-1344	SW3. CTD 500m Optics Rig 180m Plankton Nets x 2
AMT18-CTD_021 and 022	13/10/08	30°28'N 033°57'W	0405-0639	SE3. CTD 300m + 500m 2 x Bongo Nets 180m
AMT18-CTD_023	13/10/08	29°40'N 034°50'W	1216-1348	SE4. CTD 500m Optics Rig 200m Plankton Net
AMT18-CTD_024 and 025	14/10/08	27°38'N 037°02'W	0405-0637	SE3. CTD 300m + 500m 2 x Bongo Nets 180m
AMT18-CTD_026	14/10/08	26°49'N 037°54'W	1217-1341	SE5. CTD 500m Optics Rig 180m
AMT18-CTD-027 and 028	15/10/08	24°45'N 040°05'W	0405-0640	ESE4/5. CTD 300m + 500m 2 x Bongo Nets 180m
AMT18-CTD_029	15/10/08	24°45'N 040°05'W	0640-1151	ESE4/5. NAG Deep CTD to 4690m
AMT18-CTD_030	15/10/08	24°44'N 040°01'W	1151-1415	ESE4/5. 1151-1415 (incl slow-steam while taking off CTD samples to partially empty Sewage Ret.Tank).
AMT18-CTD_031 and 032	16/10/08	22°36'N 040°16'W	0405-0637	SE3. CTD 300m + 500m 2 x Bongo Nets 180m
AMT18-CTD_033	16/10/08	21°40'N 039°36'W	1222-1413	ESE3. CTD 500m Optics Rig 180m MVP deployed: 11.5 kts Max through water required
MVP Tow [3]	16-17/10/08	Passage @ reduced speed: MVP request.	1413-17/0400	MVP tow speed of 11.5 kt through water gave only 10.17 kts over ground
AMT18-CTD_034 and 035	17/10/08	19°43'N 038°14'W	0400-0635	MVP Recovered E3. CTD 300m + 500m 2 x Bongo Nets 180m
AMT18-CTD_036	17/10/08	18°48'N 037°35'W	1219-1400	ENE4. CTD 500m Optics Rig 180m MVP deployed: 11.5 kts Max through water required
MVP Tow [4]	17-18/10/08	Passage @ reduced speed: MVP request.	1400-18/0400	MVP tow speed of 11.5 kt through water gave only 10.07 kts over ground
AMT18-CTD_037 and 038	18/10/08	16°49'N 036°12'W	0400-0743	MVP Recovered NExE5/6.CTD 300m + 500m 2 x Bongo Nets 180m
AMT18-CTD_039	18/10/08	16°49'N 036°12'W	0743-1222	NExE5/6. Deep CTD 5150m
AMT18-CTD_040	18/10/08	16°49'N 036°12'W	1222-1420	NE6. Mod sea & swell. CTD 300m. Optics Rig 180m MVP deployed: 11.5 kt Max through water required
MVP Tow [5]	18-19/10/08	Passage @ reduced speed: MVP request.	1420-19/0400	MVP tow speed of 11.5 kt through water gave only 9.91 kts over ground
AMT18-CTD_041 and 042	19/10/08	14°55'N 034°56'W	0400-0630	E4. CTD 300m + 500m 2 x Bongo Nets 180m
BAS STCM [1] Calibration	19/10/08	14°55'N 034°55'W	0630-0722	Closest opportunity to Site [1] (Adverse Sea conditions precluded calibration within the specified 'box' location)
AMT18-CTD_043	19/10/08	14°06'N 034°22'W	1218-1406	ESE5. Mod sea & swell. CTD 300m. Optics Rig to 180m MVP deployed

MVP Tow [6]	19/10/08	Passage @ reduced speed: MVP request.	1406-1529	Strengthened MVP Bridle: running trial at higher speed TW TMG 11.70 Kts OG. Av Spd 11.78 Kts: No time lost
MVP Tow [6] cont	19/10/08	Recovery/redeployment @ reduced speed	1529-1557	Recover MVP to assess bridle 29m 3.7 nm covered @7.93 Kts AvSpd;
MVP Tow [6] cont	19-20/10/08	Passage @ normal speed	1557-20/0400	SMG 11.685 Kts:
AMT18-CTD_044 and 045	20/10/08	11°49'N 032°49'W	0400-0644	E4. CTD 300m + 500m 2x Bongo Nets 180m
AMT18-CTD_046	20/10/08	10°54'N 032°12'W	1220-1421	E4. Slight sea, low swell. CTD 300m. Optics Rig 180m. MVP deployed vertically to 300m prior to moving off.
MVP Tow [7]	20/10/08	Passage @ normal speed	1421-1628	No time lost
MVP Tow [7]	20/10/08	Reduced speed for recovery of faulty MVP	1628-1644	Av.Spd 3.37Kts for period;
AMT18-CTD_047 and 048	21/10/08	08°39'N 030°43'W	0405-0625	ENE3. CTD 300m + 500m 2x Bongo Nets 180m
AMT18-CTD_049	21/10/08	07°40'N 030°04'W	1220-1400	E3. Slt sea & swell. CTD 300m. Optics Rig to 180m. 2x Plankton Nets. MVP deployed
MVP Tow [8]	21-22/10/08	Passage @ normal speed	1400-0400 14h00m	SMG 11.71 Kts:
AMT18-CTD_050 and 051	22/10/08	05°20'N 028°31'W	0400-0726	SE-S3. CTD 300m + 500m 2x Bongo Nets 180m
AMT18-CTD_052 and 053	22/10/08	05°20'N 028°31'W	0726-1116	2 x Deep CTDs 2000m to obtain water for Japanese SW Standards
AMT18-CTD_054	22/10/08	05°06'N 028°22'W	1220-1400	SE2/3. Slt sea & swell. CTD 500m.Optics Rig 180m. MVP Deployed
MVP Tow [9]	22-23/10/08	Passage @ normal speed	1400-23/0400	SMG 11.76 Kts:
AMT18-CTD_055 and 056	23/10/08	02°47'N 026°51'W	0400-0629	SSE4/5. Mod sea & low swell. CTD 300m + 500m 2 x Bongo Nets 180m
AMT18-CTD_057	23/10/08	01°50'N 026°13'W	1220-1340	SExS6. CTD 500m.Optics Rig 180m. Plankton Net x 2 MVP Deployed
MVP Tow [10]	23-24/10/08	Passage @ normal speed	1340-24/0400	SMG 11.67 Kts:
MVP Tow [10]	23-24/10/08	Reduced Speed MVP request for 43 mins	1730-1813	Distance MG 6.7 nm Time lost = 9 mins
AMT18-CTD_058 and 059	24/10/08	00°35'S 025°00'W	0400-0633	SExS4/5. Mod sea & low/ mod swell. CTD 300m + 500m 1 x Bongo Nets 180m
AMT18-CTD_060	24/10/08	01°37'S 025°00'W	1148-1420	SE3/4. CTD 500m.Optics Rig 180m. MVP Deployed
MVP Tow [11]	24-25/10/08	Passage @ normal speed	1420-25/1215	SMG 11.78 Kts:
AMT18-CTD_061	25/10/08	06°03'S 024°59'W	1215-1353	SE5. CTD 500m.Optics Rig 180m. MVP Deployed.
MVP Tow [12]	25-26/10/08	Passage @ normal speed	1353-26/0400	SMG 11.72 Kts:
AMT18-CTD_062 and 063	26/10/08	08°50'S 025°00'W	0400-0627	ExS4/5. Mod sea & low/mod SE swell. CTD 300m + 500m 2 x Bongo Nets 180m

AMT18-CTD_064	26/10/08	09°58'S 025°00'W	1215-1343	SE5. Mod sea & low/mod SE swell. CTD 500m, Optics Rig 180m. MVP deployed
MVP Tow [13]	26-27/10/08	Passage @ normal speed	1343-27/0400	SMG 11.80 Kts:
AMT18-CTD_065 and 066	27/10/08	12°50'S 025°00'W	0400-0633	SE3. Slt sea & low SE swell. CTD 300m + 500m 2 x Bongo Nets 180m
MVP Tow [14]	27/10/08	Passage @ normal speed	0633-1220	SMG 11.79 Kts:
AMT18-CTD_067	27/10/08	14°00'S 024°58'W	1220-1344	SE4. Slt sea & low SE swell. CTD 500m, Optics Rig 180m, 2x Plankton Nets. MVP deployed
MVP Tow [15]	27/10/08	Passage @ normal speed	1344-1845	SMG 11.70 Kts:
AMT18-CTD_68	27/10/08	15°00'S 024°58'W	1845-1936	CTD 20m
MVP Tow [16]	27-28/10/08	Passage @ normal speed	1936-28/0400	SMG 11.65 Kts:
AMT18-CTD_069 and 070	28/10/08	16°38'S 025°00'W	0400-0721	NE3. CTD 300m + 500m, 2x Bongo Nets 180m,
AMT18-CTD_071	28/10/08	16°38'S 025°00'W	0721-1116	NE3. Deep CTD to near bottom. 4530m depth
AMT18-CTD_072	28/10/08	16°52'S 025°00'W	1220-1342	NE3. CTD 500m, Optics Rig 180m . MVP deployed
MVP Tow [17]	28/10/08	Passage @ normal speed	1342-1845	SMG 11.68 Kts:
AMT18-CTD_073	28/10/08	17°51'S 025°00'W	1845-1922	CTD 20m
One big Main Engine Tripped out, causing loss of Propulsion etc	28/10/08	BAS time,	1927-1946	MVP Recovered, and redeployed on restoration of propulsion power.
MVP Tow [18]	28-29/10/08	Passage @ normal speed	1955-0220	SMG 11.55 Kts:
AMT18-CTD_074 and 075	29/10/08	19°08'S 024°59'W	0220-0632	NxE3. CTD 300m + 500m, 2x Bongo Nets 180m. MVP deployed
MVP Tow [19]	29/10/08	Passage @ normal speed	0632-1220	SMG 11.78 Kts:
AMT18-CTD_076	29/10/08	20°17'S 025°00'W	1220-1330	NW4. CTD 500m, Optics Rig 180m, Plankton Nets x2.
	BAS STCM [2] Calibration	29/10/08	20°17'S 025°00'W	1330-1418
MVP Tow [20]	29/10/08	Passage @ normal speed	1438-1845	SMG 11.73 Kts:
AMT18-CTD_077	29/10/08	21°07'S 025°00'W	1845-1935	NW3/4. CTD 20m
MVP Tow [21]	29-30/10/08	Passage @ normal speed	1935-30/0400	SMG 11.90 Kts:
AMT18-CTD_078 and 079	30/10/08	22°47'S 025°00'W	0400-0640	SW4/Lt.Airs. CTD300m + 500m, 2x Bongo Nets 180m
MVP Tow [22]	30/10/08	Passage @ normal speed	0640-1220	SMG 11.87 Kts:
AMT18-CTD_080	30/10/08	23°56'S 025°00'W	1220-1330	NW4. Slt/mod sea, mod swell. CTD 500m, Optics Rig 180m
Buoy Deployment (AMT	30/10/08	23°58.7'S 025°00'W	FLOAT [1] ARGO [1]	Buoys deployed. Running at Av.spd. 7.5 Kts 1330-1410.

requirement)		23°59.3'S 025°00'W		
One big Main Engine Tripped out, reduced speed.	30/10/08	BAS time	1452-1503	Shortened MVP towline, and paid out and resumed Tow on restoration of full power.
MVP Tow [23]	30/10/08	Passage @ normal speed	1410-1845	SMG 11.41 Kts (allowing for propulsion loss 1452-1503)
AMT18-CTD_081	30/10/08	24°52'S 025°00'W	1845-1934	CTD 20m
MVP Tow [24]	30-31/10/08	Passage @ normal speed	1934-31/0400	SMG 11.73 Kts:
AMT18-CTD_082 and 083	31/10/08	26°33'S 025°00'W	0400-0731	NNE3. CTD300m + 500m, 2x Bongo Nets 180m
AMT18-CTD_084	31/10/08	26°33'S 025°00'W	0731-1230	Deep CTD 4571m
AMT18-CTD_085	31/10/08	26°33'S 025°00'W	1230-1404	NNE4. Slt/mod sea, mod SSW swell. CTD 300m, Optics Rig 180m. 2x Plankton Nets
Buoy Deployment (AMT requirement)	31/10/08	26°33.4'S 025°00'W 26°35.8'S 024°59'W	ARGO [2] FLOAT [2]	Buoys deployed. Time included in Station [59] above.
One big Main Engine tripped out, Aft Prop Motor tripped out; reduced speed.	31/10/08	BAS time, not included in MVP Tow [25] calculations.	1708-1740	Shortened MVP towline, and paid out and resumed Tow on restoration of full power.
MVP Tow [25]	31-01/11/08	Passage @ normal speed	1404-01/0400	SMG 11.53 Kts (allowing for propulsion loss and reduced speed 1708-1740)
AMT18-CTD_086 and 087	01/11/08	28°52'S 026°04'W	0400-0636	NWxW6. Mod/rough sea, mod swell. CTD300m + 500m, 2x Bongo Nets 180m
MVP Tow [26]	01/11/08	Passage @ normal speed	0636-1215	SMG 11.66 Kts:
AMT18-XX		29°38'S 026°57'W	1215-1249	WxN8/9 gusting 45+. Rough sea, mod/heavy WxN swell. Station cancelled due to rough conditions. Hove-to for Buoy deployment and stowing of CTD in WBA
Buoy Deployment (AMT requirement)	01/11/08	29°37.9'S 026°57.5'W 26°35.8'S 024°57.5'W	ARGO [3] FLOAT [3]	Buoys deployed. Time included in Station [XX] above.
MVP Tow [27]	01-02/11/08	Passage @ normal speed	1249-02/0400	SMG 08.32 Kts: Speed reduced in Hvy Weather
AMT18-XX	02/11/08	31°08S 028°52'W	0400-0435	Hove-to, to assess sea conditions for station: not workable. SSW 6/7, mod/rough sea, mod/heavy SSW swell. Deck experiments tended.
AMT18-CTD_088 and 089	02/11/08	32°11'S 029°49'W	1220-1549	S4/3. Slight Sea, Mod swell CTD 300m, CTD 500m, Optics Rig 180m, 2x Plankton Nets
Buoy Deployment (AMT requirement)	02/11/08	32°10.8'S 029°50.5W 32°11.0'S 029°50.5'W	ARGO [4] FLOAT [4]	Buoys deployed. Time included in Station [61] above.
MVP Tow [28]	02-03/11/08	Passage @ normal speed	1549-03/0400	SMG 11.74 Kts:

AMT18-CTD_090 and 091	03/11/08	33°46'S 032°00'W	0400-0645	SW2/3. Slight sea, low E'ly swell. CTD300m, CTD 500m 2x Bongo Nets 180m.
MVP Tow [29]	03/11/08	Passage @ normal speed	0645-1220	SMG 11.78 Kts:
AMT18-CTD_092	03/11/08	34°33'S 032°59'W	1220-1351	SWxW3. CTD500m, Optics Rig 180m, 2x Plankton Nets
MVP Tow [30]	03-04/11/08	Passage @ normal speed	1351-1658	SMG 06.80 Kts: MVP recovered – spooling problem.
AMT18-CTD_093 and 094	04/11/08	36°10'S 035°03'W	0305-0530	NE2. CTD 300m, CTD 500m 2x Bongo Nets 180m
MVP Spooling	04/11/08	36°10'S 035°03'W	0530-1218	On station, veered MVP cable with weights (80kg) to full length to adjust spooling.
AMT18-CTD_095	04/11/08	36°10'S 035°03'W	1218-1341	NW3. CTD 500m, Optics Rig 180m, 2x Plankton Nets
AMT18-CTD_096 and 097	05/11/08	37°58'S 037°24'W	0305-0542	NW5/6. CTD 300m, CTD 500m, 2x Bongo Nets 180m
AMT18-CTD_098	05/11/08	38°45'S 038°27'W	1205-1326	NW6/7. CTD 500m, Optics Rig 180m, 2x Plankton Nets
Buoy Deployment	05/11/08	38°45.2'S 038°26.9'W	FLOAT [5]	Buoy deployed. Time included in Station [67] above.
Sci Gear sorting on deck	05/11/08	38°45.2'S 038°26.9W 38°51.2'S 038°28.9'W	1326-1412	Off course to permit sorting Sci Gear on Deck coming off station: Time lost: 15 min
AMT18-XX	06/11/08	40°17'S 040°28'W	0200	Heavy Weather: 0315 Station cancelled. NW9 rough sea, heavy NW'ly swell.
AMT18-NN	06/11/08	40°50'S 041°15'W	0702-0716	Turned to run downwind to service Deck incubators
AMT18-CTD_099	06/11/08	41°28'S 042°08'W	1205-1331	SW6. Mod sea & swell. CTD 500m, Optics Rig 180m, 2x Plankton Nets
Buoy Deployment (AMT requirement)	06/11/08	41°28.8'S 042°08.1'W 41°28.9'S 042°08.2'W	ARGO [5] FLOAT [6]	Buoys deployed. Time included in Station [68] above.
AMT18-CTD_100 and 101	07/11/08	45°13'S 044°37'W	0305-0647	Lt. Airs. CTD 300m, CTD 500m, 2x Bongo Nets 180m, MVP cable veered to max 2x with clump weight, transferred from mooring winch to MVP winch
AMT18-CTD_102	07/11/08	43°57'S 045°39'W	1204-1330	NNW4. CTD 500m, Optics Rig 180m.
Buoy Deployment (AMT requirement)	07/11/08	43°57.3'S 045°38.6'W	FLOAT [7]	Buoy deployed. Time included in Station [70] above.
AMT18-XX	08/11/08	45°50'S 048°26'W	0405-0451	NNW7/8. Rough seas, mod/hvy swell. Hove-to to assess conditions.
AMT18-nn	08/11/08	46°47'S 049°32'W	1130-1212	NxW 7/8. Running downwind to allow removal of Sci. Eqpt from Bow.
AMT18-71	08/11/08	46°55'S 049°31'W	1212-1345	NxW7/8. Optics Rig 180m. De-mob: transferring packing cases from aft deck container to labs.
AMT18-XX	08/11/08	47°27'S 049°54'W	1634-2029	NWxN7/8. Hove to for de-mob facilitation. Backed WxN8/9 at finish.

BAS STCM [3] Calibration	09/11/08	49°46'S 055°20'W	

10th November 2008

Sample collection and deployment requests from external collaborators

i) Water sampling for ^{18}O- and ^{13}C-analysis and zooplankton samples for foraminifera analysis

Request from: Dr. Antje Voelker, LNEG (Laboratorio Nacional de Energia e Geologia), Departamento de Geologia Marinha Estrada da Portela, Zambujal, 2721-866 Alfragide, Portugal.

See Appendix 3 a and 3b for sampling stations and details.

ii) Deployment of Argo floats and Irridium Ocean Drifter buoys for The Met Office

Request from: Jon Turton, Met Office, FitzRoy Road, Exeter, Devon, EX1 3PB
The request was to deploy from the JCR a number of ARGO floats in the South Atlantic, these to be around the southern turn. There were also a number of irridium oceanic drifter floats which were launched over the ships stern rail whilst leaving the sampling CTD stations.

See the cruise blogs for photos of the floats and their deployment.

See Appendix 5 for details of the launch positions of all the floats and buoys.

iii) d13C and DIC samples, taken by Martine Couapel

For Jodi Young and Ros Rickaby at Oxford University

iv) Samples for bulk DNA analysis, taken by Martine Couapel.

For Colomban de Vargas at the Roscoff Marine Laboratory, France

v) Atmospheric Sampling:

Manuela Martino & Alex Baker, School of Environmental Sciences, University of East Anglia.
Aerosol samples were collected by John Pearman of Warwick University during the cruise. Two high volume aerosol collectors were situated on the monkey island, each equipped with a cascade impactor, allowing separation of the aerosol into sub- and super-micron size fractions. Filters contained in one collector were for analysis of aerosol major ion chemistry, while those in the other were for determination of trace metal content. Sampling commenced on 7th October 2008 and finished on 8th November 2008, with filters being changed once each day initially and then every two days in the cleaner air south of 10S. A total of 22 paired major ion and trace metal samples were collected. All samples were stored frozen for later analysis at the University of East Anglia.

The primary aim of the sampling was to investigate the atmospheric supply of soluble nutrient species (Fe, N, P) to the Atlantic Ocean. Aerosol chemistry and size distributions will be used provide information on the sources and fate of these nutrients (e.g. Baker et al., 2006). This will contribute to the UEA group's on-going assessment of atmosphere nutrient supply to the Atlantic Ocean, along with our results from the previous 6 AMT cruises and 4 other similar transects during the period 2000-2008.

We would like to thank John Pearman and Malcolm Woodward for their assistance in collecting samples for us.

Baker, A.R., Jickells, T.D., Biswas, K.F., Weston, K. and French, M., 2006. Nutrients in atmospheric aerosol particles along the AMT transect. Deep-Sea Research Part II, 53: 1706-1719.

Cruise Internet Blogs: The Story of the Cruise

As a way of disemminating information and the daily cruise news to a wider audience and to give a flavour of the day-to-day life onboard, the AMT-18 cruise was chosen as one of the first 'bloggers' for the new Google-Earth global website that was launched whilst the AMT-18 cruise was at sea.

This was a prestigeous event for PML and the AMT programme and all the cruise participants were able to write and comment on the cruise events as we went south.

There follows the Google-Earth Blog pages and then a second cruise blog from Martine Couapel and Jeremy Young from the Natural History Museum in London who had their own version of tales to tell. These both complement each other to give the reader a good feel for the cruise stories and events.

Google Earth Version:

Farewell Blighty – Tuesday 7th October 2008

A scientific cruise can be a journey of discovery into the unknown. We pulled out of Immingham at 9:00am on 3 October through the port gates to the Humber into the choppy brown waters of the North Sea. The wind was gusting up to 50mph. There were white caps as far as the eye could see. The ship lurched from port to starboard battling into the wind taking us through the Southern Bight into the English Channel. These first few days certainly separate the experienced sea goers from the novices. The restaurant reduces in numbers and balancing the soup bowl, a drink and cutlery becomes a veritable art.

As we passed through the channel, on the morning of 4th October, there was a lull in the weather and momentary sense of calm and all seemed well. The dirty brown North sea had given way to a turquoise green, indicative of a phytoplankton bloom in the Channel. Then as we sailed south through the Western English Channel and over the Celtic Sea shelf the weather worsened and we were battered by a front from the south. Normally we would sample in this area to link in with measurements being made off Plymouth at a time series station by Plymouth Marine Laboratory (www.westernchannnelobservatory.org.uk) and deploy profiling instruments to get an idea of the temperature, salinity and fluorescence of the water column and collect water samples to conduct our myriad of analyses and experiments. In these conditions, however, we were not allowed out on deck let alone to put instruments over the side. The sea was washing over the afterdeck and waves crashing onto the bow of the ship. At meal times in the restaurant it was literally like being in a car wash. We were almost hove to on 4th and 5th October; the ship steaming head to wind to maintain a near static position. The sea is a chameleon of many colours!!!

The wake after the storm – Thursday 9th October 2008

RRS James Clark Ross Bridge-cam

Setting the scene

On 5th October after the force 9 storm, we started the science proper. There are 21 scientists from 7 institutes on board who make a broad spectrum of measurements that helps improve our understanding of the biological, chemical and physical dynamics of the Atlantic Ocean. The Atlantic Meridional Transect programme is hosted by Plymouth Marine Laboratory (PML) and is a national UK capability for long term multi-disciplinary oceanographic observations and marine research in the Atlantic. It has been running for 12 years; the first phase served as a platform for validating NASA satellite observations, the second, to study the microbial dynamics in the ocean deserts and this new and third phase is funded by the UK government under the programme Oceans 2025* as a time series of sustained observations in the Atlantic on the structure and biogeochemical properties of plankton ecosystems in the Atlantic Ocean. In a nutshell, to assess 'the health and state of the Atlantic Ocean'.

There are six scientists from the PML (Chris Gallienne, Carolyn Harris, Vasilis kitidis, Glen Tarran, Gavin Tilstone, Malcolm Woodward) who are measure everything from the optical properties, nutrients, photochemistry, phytoplankton community structure, phytoplankton respiration and carbon fixation and macro-zooplankton abundance to enhance our understanding of the biological, optical and chemical properties of the Atlantic Ocean. Paul Mann, a PhD student from the University of Newcastle is working alongside the PML nutrient and photo-chemistry teams. Mario Vera, a POGO fellow from Columbia, also works alongside the PML team on phytoplankton respiration.

There are five scientists from National Oceanography Centre (NOC) who also cover a wide spectrum of measurements studying the biology and physics of the Atlantic Ocean; Mike Zubkov's team Ros Holland and Manuela Hartmann measure the abundance of marine bacteria, pico and nano-plankton (very small phytoplankton 0.2 to 2 microns) and micro-zooplankton and their uptake of nutrients. Stuart Painter and Jo Hopkins measure the physical properties (temperature and salinity) of Atlantic Seawater.

One scientist (Bruce Bowler) is from Bigelow Laboratory in the US. Bruce is a one man band measuring everything from the reflectance of the sea surface to absorption and backscatter, the biomass, calcium and carbon content of the microscopic calcareous, marine plants known as the Coccolithophores. Martin Ostrowski and John Pearman from the University of Warwick work alongside Mike's team studying the genetic diversity of the phytoplankton and bacterial communities. Jeremy Young and Martine Couapel, from the Natural History Museum, study the abundance and genetic diversity of Coccolithophores.

All of this work is underpinned by Terry Edwards and Dave Teare from National Marine Facilities, Southampton who operate all of the overside instruments, Ben Tullis from the British Antarctic Survey, Cambridge who provides IT support and of course the crew and

officers of the James Clark Ross who do everything from deploying our instruments, steering our course and turning out 3 course sumptuous meals three times a day.

* Oceans 2025 is a multi-disciplinary research program looking at changes in marine systems in a high CO2 world.

KT Tunstall – Thursday 16th October 2008

Currently typing away in time to KT Tunstall. Oh yes, it's 1930 here and I'm about to turn in to try and get 8 hours sleep for once. I figure if I lie in bed for 8.5 hours I might get 8 hours sleep out of it. Unbelievable luxury. It basically means everything went smoothly today. If you are as mathematically challenged as I am, that means getting up at 0400, for the first conductivity-temperature-density (CTD) trace. The poor blighters analysing nutrients have to get up at 0300 to set up their instruments, so I guess I'm lucky.

Just as a random comment, we crossed the Tropic of Cancer overnight (23.5 degrees N). The next big line will be the equator, probably in 6 days time. There are loads of people who haven't had the pleasure of meeting Neptune before and a couple I know of who have been foolish enough to forget their certificates, so they cannot prove they've crossed the line before. This basically puts them back in the firing line of Neptune's justice. First timers beware: Neptune can be harsh to those traversing his realm and the crew can carry out all sorts of unmentionable things to crossing the line initiates in His name.

Oh, by the way, it's really difficult typing in the dark but as my cabin faces west I had a lovely view over the sea just after sunset when I started typing and couldn't be bothered to move. It really is very dark already. We're in the Trade winds at the moment, so it's a brisk force 4-5 all the time. RRS James Clark Ross seems happy with it though. The bruises I obtained during our stormy transit down the North Sea and English Channel have been munched by my white blood cells now so I don't look quite so battered any more. Coo, I've just realised, this is the end of our 14th day at sea. 24 to go!!

Right, that's the end of KT Tunstall so time to turn in. Mmmmmmm, perhaps a little chocolate first?……..

Hot, hot, hot – Thursday 16th October 2008

Hot, sweaty, currently letting my feet breathe. Training shoes have got up and walked off on their own! Heat generated by 2 flow cytometers in the main lab is like having a 3 bar electric fire on ALL day. The air coming off the lasers is also a tad warm. Main lab is now festooned with ducting, a mobile air con unit and in-line fans in an attempt to dump heat out of the lab and keep the instruments cooler. The humans will just have to suffer. 34 degs C in the lab at the moment, so I've escaped for an hour before the next water samples (conductivity and temperature with depth) are hoisted up.

AMT18: Reflections after 2 weeks at sea.
The first report from Malcolm Woodward, Chief Scientist

Thursday 16th October 2008

Or "haven't I been here before …….. well yes maybe just the once or twice"

So here is the first of a series of pieces to try to outline and explain how we got here and what we are doing out here.

The organising of an international research cruise has become over the years a long complicated business, with the biggest increase in the required paperwork, and of course the paperwork, oh yes and then more paperwork. But in amongst all that we must not lose sight of the most important thing, the science. With getting equipment prepared, long lists are required to ensure just about every conceivable spare and consumable is purchased well within time (some filters from a well known UK company did not arrive in time despite being ordered in June this year and promises that they 'would be here soon sir'). So you get around these things, beg and borrow off colleagues left at the lab until finally the boxes are

all packed up, chemicals boxed up according to the IMDG code (International Maritime Dangerous Goods code). If you thought 'war and peace' long then if you cannot every sleep then get your nose into these mighty volumes …. zzzzzzzzz.

The paperwork and pre-cruise requirements that have to be submitted consist of medical forms, dental forms, a sea-survival course (that's a fun day), injections, personal details form with next of kin, etc, (going to sea is a hazardous profession), personal account forms to pay for at-sea expenditure, plus all the risk assessments, safe working practices, COSHH assessments for chemical use and all the hazard information for all the chemicals to be used. Luckily AMT has the invaluable help as part of the backroom team of Julia Crocker at PML, she puts it all together, phones and emails and gently persuades people to ensure we get all the forms in on or near time, and then they are all submitted to BAS (British Antarctic Survey) logistics for processing. Oh yes, haven't said who I am, Malcolm Woodward, nutrient chemist of too many years, and as well as that for some strange reason the logistics co-ordinator for the scientists on the AMT cruises. And that's all the way back to AMT-1, 1995, I remember it well, Prof Jim Aiken, David Robins, Roger Harris, Tony Bale, legends all in the annals of AMT, but that was the pioneering days when it was 6 men (and boys) plus of course some females, that went out and started this internationally acknowledged programme. Back then of course I was a mere child in arms, and had a full head of hair, yes honest!

So finally with all the paperwork done, all the PML equipment was packed and we loaded the lorry on Monday September the 29th, boxes of all shapes and sizes, weights marked sometimes out of Enid Blyton, especially when sometimes a '25Kg' box needs four people to lift it!! But with help from other PML colleagues the lorry was soon packed and left for the trip north.

The PML scientific party left the following morning in 2 cars bright and early from Plymouth, Ivybridge, Torquay and a number of points in between and around. Others converged from Warwick, Newcastle, the US of A, London, La Belle France, Colombia and beyond.

We arrived safely in the wondrously (sic) scenic port of Immingham where the JCR (James Clark Ross) was mobilising a dizzying array of equipment, stores, spares, tons of food, frozen and not, shipping containers were being stacked on her decks, plus below decks, all for her trip south and for the relief of the BAS bases in the Antarctic for whom the arrival of the JCR would be the first meeting with non base people since before the start of the very cold and dark Antarctic winter.

We loaded all the scientific gear onto the ship on the Tuesday evening and into the ships laboratories, people had been allocated their cabins so the process of mobilising the ship with equipment and getting all your personal clothing, and personal items that you have to take for 6 weeks away at sea all to be boxed and stored safely for sailing.

As PSO (Principal Scientist) I have to suffer a rather modest suite with separate office and comfy chairs, affectionately known as the 'penthouse suite', the others have all bar one couple, got cabins to themselves as well as we are not filling the ship this cruise, so its pretty relaxed and spacious around the place. However for this great honour as PSO you do have to suffer, that cabin is not the place to be in any sort of sea as it is on the top deck below the bridge and subject shall we say to a tad of movement in a seaway. Luckily I am not affected by such things but if you were there oh dear it's a bit of a 'washing machine' ride at times up there.

So who are the major players in the forthcoming soap-opera called AMT18, well, dip into the AMT website at www.amt-uk.org there you will find the cruise personnel photos, scary, some details of the science, all the past AMT cruises and lots more stuff.

So here we are at the dawn of a new era of AMT cruises, the NERC consortium grant led by Carol Robinson has ended, sadly Carol has also ended her time at PML for pastures new, so the new team, well I'm not new as I've been logisticing (is that really a word?) since the start, is being led by Andy Rees as the new Head of AMT at PML.

The new funders of the 'new' AMT is the NERC core science funded Oceans 2025 programme, with PML leading along with NOC as the main partner, this adding the important element of Ocean Physics to the science that has been badly missed before. Stuart and Jo are with us this cruise to redress the balance of that knowledge, with an initial few days of help from John Allen before he jumps ship in the Azores.

A pre-sailing meeting was held for all scientists to say hello and for people to put names to faces for those who had not been to the pre-cruise planning meets. The ship also called a practice emergency muster station, which in our case is to go to the bar with life jacket and survival suite, this is to check people know what to do in the case of emergency, and to hear and identify the various different alarms that can be sounded. A trip to the lifeboats and strapping in followed and more safety instructions 'in the unlikely event' of us having to do it for real. Slightly sobering to think about with so many people in such a small craft trying to stay alive in a rough sea.

So with everything ready, tied, screwed and lashed down in the labs we cast off on a dull, grey morning, Friday October 3rd. We left the dock, aided by 2 tugs and inched our way into the lock before passing though into the outer mouth of the Humber River and towards the North Sea. A few family were there to say goodbye, the ships doctor Nerys had her parents waving goodbye as she is leaving to spend the whole time as ships doctor this trip, only returning to the UK in May/June next year, a fantastic experience awaits her but also a long time away from friends and family, good luck.

Out of the Humber and into the North Sea we were straight into a very lumpy sea, luckily from our stern so we made good progress. Overnight we went through the Dover straights where I was very calm and the next morning we awoke to see Beachy Head of our starboard quarter.

We stopped finally after passing the Isle of Wight, moving out of the shipping lanes and carried out a test for the CTD (conductivity, temperature, depth) system with our water bottle sampling rosette system as an integral package (see photo above). This will be the main sampling device for the whole of the cruise so very important to check it is working and the computers are talking to the sensors and vice-versa. All was well and we continued westwards into the big swell. Should mention the very important NMF (National Marine Facilities, Southampton) technicians who had become responsible for the CTD system by default as one of the BAS technicians had sadly been unable to come on the cruise at the last minute, so they manfully stepped in to cover the loss of support with the CTD. Terry and Dave are those stars and they will appear at numerous junctures during the cruise narrative I am sure. We also trialled our towed fish/instrument package, the MVP (Moving Vessel Profiler) giving it a test dip. All seemed to go well, a tutorial was held for those who had never sampled from the 10 and 20 litre water sampling bottles before, how to release the pressure and open the taps along with stressing the importance for 'clean' sampling for some of the science like the nutrients, oxygen etc. So soon we were on our way again, most people were up and about and we had now moved into the coming cruise food routine. After

a while these often become the high spots of the day to give a break with the routine of science. Breakfast in the saloon at 0730, lunch at 1200 and dinner 6-7pm, although after the Azores this would return to one sitting at 6.30pm. To eat in the saloon then 'clean and tidy' is the rule with collared shirts in the evenings for the guys and smart for the ladies, so not too onerous! We also have the option to eat in the duty mess if you have to eat quickly or can't change out of work-wear for some reason.

As the morning wore on down the Channel the seas became bigger and the wind increased such that soon we were battering into a force 8-9, not a good start for the trip and a number of the scientific 'skittles' were again knocked down for a while and confined to cabins. Saturday was 'bouncy' and progress slow, we passed Start Point overnight and were being thrown all over the place, home was not far away and I wondered if my roof was still hanging on with this south-westerly gale. The idea to carry out a scientific station of Plymouth close to the E1 Channel Observatory (http://www.westernchannelobservatory.org.uk/) was shelved as it was difficult to stand up let along do anything useful scientifically.

We bounced out to the Western Approaches and past the Scilly's away in the distance and the last sight of the UK with the Bishop Rock lighthouse back of our stern.

Sunday bounced past as we crashed through a big south westerly gale heading out to the Celtic Sea, generally preparing stuff in the labs those of us who were up and about and others probably lying in their bunks feeling bad and wishing and praying for it all to end. Overnight saw a dropping in the wind and the plan was to start scientific operations on the Monday morning the 6th with a pre-dawn CTD at 0430 into the water. And as if to welcome us and celebrate the start of the science there was a pod of 12-15 common dolphins all around us as we started the sampling. Just great seeing them leaping out of the water with a real joy for life.

The water sampling requirements make it necessary for us to carry out 2 pre-dawn CTD drops to accommodate all the required water demands of the disparate groups on board. The first goes to 300 metres, with the 24 bottles being fired at the water column depths determined on one hand by the depth of light penetration into the water with samples taken at 97% (closest to the surface), 55%, 33%, 14%, 7%, 3%, 1%, and 0.1% of the light. Also there are other requirements to take samples around the subsurface chlorophyll maximum (a measure for algae) and thermocline (warm layer that forms in the summer over the oceans) features in the water column. As the CTD is launched and goes deeper there is a computer read-out for various parameters that are shown on screens in the operations room, these show, salinity, temperatures, fluorescence, oxygen, light irradiance, and others. So, when the CTD reaches the bottom of the cast, in this case 300 m then on the way up it allows the scientists to target features and specific depths and then be able to have a suite of back-up data recorded at the moment the bottle is fired at that depth. Getting this sorted took me one

long evening with a couple stiff supportive tonics to be able to ensure that everyone was happy with their water and depth allocations. Luckily, or due to brilliant pre-planning (must keep the modesty in check!), it all seemed to work, occasionally the odd misfiring bottle causes the loss of a depth but those thankfully are pretty rare. After the first CTD the water is then collected in a sort of rugby-esque type scrum of scientists in safety boots, hard hats, white lab coats and clean gloves. There is indeed also a 'pecking-order' for the order of sampling and woe betide those who jump out of it and try to grab their water first, words of retribution quickly fly.

Whilst all this frenzy of water grabbing is going on there is a much more refined and sedate scientific operation occurring up at the forward quarter of the ship with the sampling to 180 metres using what are called Bongo nets, basically a pair of plankton nets secured by rings that sample up through he water column to give us some ideas of the plankton species types and amount of biomass there is at a particular site. Chris is up their all alone doing that sampling, very much the classical sampling technique changed little in years, rather than the high-tech of the CTD operation.

Once the water has been extracted then the CTD bottles are again re-cocked and the system is lowered back over the side for a cast to 500 metres in order to collect more physical information about the water column, before bringing it back up for another firing sequence and then back on deck for the next batch of water-hogs to dive in for their turn at sampling the ocean.

That done and once all is secure and happy then it's of again on track heading for the solar noon station at about 1230.

So once the samples are all collected then its all back to the lab and many hours of processing begins, some are chemically analysed for say nutrients, lots of the water is filtered for future analysis back in the UK and elsewhere for everything from microscopy, genomic studies and chlorophyll concentrations. Also experiments are started and conducted with the water from investigating the productivity of the phytoplankton, to adding microscopic amounts of radioactive labels to investigate uptake of nutrients by the plankton. So lots of work to process the water and over the next few weeks I will get various people to describe more of their own work on board.

Then very soon the morning goes by, lunch is consumed and then the ship stops again for the solar noon CTD. A similar CTD activity takes place as at pre-dawn but this time there are less takers for the waters as most of the experimental set-ups are with pre-dawn water, so this sampling is for nutrients (nitrate, nitrite, phosphate, silicate and ammonium), oxygen, CDOM (coloured dissolved organic matter), DOC (dissolved organic carbon) and for sampling for coccolithophores by Jeremy and Martine from the Natural History Museum in London (full description to come), the first time that famous organisation has joined an AMT so I am sure a new and interesting experience for those guys coming to sea.

This time while the CTD goes down we have an 'optics' cast from the starboard stern quarter where a number of water optical properties and other gizmos are lowered on a Kevlar wire to a couple hundred metres, this giving us information for example about the light penetration depth of the water which then helps to target the light depths for firing the bottles during the CTD.

That then is the end of the over-side activities for the AMT scientists this day, but still the work is intense in the labs dealing with all the water for the rest of the afternoon and evening.

I have a small note that says…'sunshine sited for first time at 1445'. It was not to last long.

We have along with us on board a 4 person team led by Peter Enderlein of BAS who have hitched ride to the Azores in order to test an array of the overside acoustic systems on board with the aim to cross-calibrate these ready for cruises later in the year and next down in the Antarctic, names and acronyms like EK60, Swath bathymetry, ADCP, XBT, etc were talked about as we carried out a test survey track for them on the continental shelf edge. They

pronounced this a success after many hours of staring at computer screens and printouts, tweaking of settings and many meetings to discuss things. So that achieved we continued west to the first major waypoint the at the PAP (Porcupine Abyssal Plain) observatory site where the National Oceanography Centre, Southampton have a long term mooring, well that's when it's not getting frustratingly trawled up by passing itinerant fishermen! (http://www.noc.soton.ac.uk/pap/index.php)

The pre-dawn CTD's and nets were carried out within about 10 miles of PAP, on completion we turn to the south-west and headed for the Azores with the aim to arrive on Friday the 10th. A trial MVP tow was tried but this was not very successful with problems of the ship travelling too fast and this distorted the tow bridle even though it should be rated to 20 knots and we were travelling at about 14 over the ground. MVP operations were decided to be suspended until after the Azores when ship speed would be less.

The weather again deteriorates as we head to the Friday boat transfer and doubts are expressed as to whether we will get there in daylight, missing this would mean a wasted overnight stop of the port waiting for daylight. To help this we sacrifice one afternoon CTD/optics station to ensure our timely arrival. The predawn sampling continued though as normal and gradually the results started to build up and more interesting deeper waters were found after crossing out to the open ocean from the shelf waters of the UK.

Friday morning was a proper fire drill, a muster in the ships bar, everyone is designated to either the port or starboard lifeboats and everyone is checked of just like if it was a real situation. Then we were sent to the starboard deck to have a description and some lessons in setting of different types of extinguishers and identifying which is right for which particular fire. Red water, black is carbon dioxide, cream is foam, well it was until the wondrous EU decided to colour them all red. Yes, much clearer of course, there are just small identifying patches of the old colours now….genius !

So with the weather abating the sun came out and late in the morning the coast of Sao Miguel Island in the Azores came into view. It was a time to go and see the world after all the samples had been processed, some lucky ones saw 3 sperm whales not far offshore along with 3-4 dolphins, but by the time word got around they had long gone. The island looked very beautiful and inviting in the sunshine, a green patchwork of fields clinging to the steep sides of long extinct caldera. Steep cliffs looked down onto the blue Atlantic waters, it really did look very inviting. Various amusing debates were had about could we swim ashore and escape, and camera lenses clicked as photos were taken in abundance. We arrived of Punta Delgada at 1550 and very soon the pilot launch was out to us and the 4 BAS scientists and John Allen from NOC were aboard and whizzing ashore, almost immediately the JCR started her main engines, turned to the south west again and Punta slowly became a spot in the distance as we steamed away. Always mixed emotions these boat transfers, nice to see some land rather than the never ending sea, but you don't actually get ashore and that can be frustrating when a nice walk of more than 20 metres in a straight line would be a very great joy. Just one of the simple things in life that you take for granted on land but on a ship there is always a step, or equipment in the way you have to clamber over.

The next morning Sunday 11th was then back to the daily routine once again with the 2 pre-dawn CTD's, nets, solar noon CTD and an optics cast and so the die was cast for the next 30 days, a very long way to go to the other end of the earth and an awful lot of water to catch, analyse and filter…..but that's the glory of the AMT!!

The AMT website has the track laid out on an ocean colour chart of the globe, and this will be the track that all of the 5 planned AMT cruises of this Oceans 2025 funded series will occupy.

The next few days passed by with the long hours and repetitive work keeping everyone pretty tired and with little time for much socialising, the evening meal is normally the time when most people congregate together, share a pre-dinner drink and then get time to sit and enjoy the food, afterwards though there is little time free as many have to get to bed in readiness for getting up at 3am to start it all up again for the next station.

On the 14th though we celebrated Vas's birthday on board, he kindly provided wine for the dinner tables and after presenting him with his card there was the usual rendition of Happy Birthday (not quite X factor material, although maybe we could audition). It would have been good to have been able to carry on celebrating into the evening but the consequences the next morning are just not worth it. Sleep becomes the over-riding influence and you grab it when you can at any time.

The next day the 15th we arrived at the mythical NAG site (North Atlantic Gyre), which used to masquerade under the name NOG (Northern oligotrophic gyre), but somewhere along the way it got changed, still not sure why.

Here we have established one of 2 AMT bottom mooring arrays that have a series of sediment traps set up to catch the falling matter from the upper ocean and these are set at about 3000metres deep. This was in the centre of the north Atlantic gyre region and the farthest west the cruise track will go, also it marks the turning point as we now turn almost south to head for the equator. So at this station we carried out the first deep CTD with the deepest sample taken at 4690 metres. Along with having to take of various sensors that will not stand the pressure at those depths there is also the traditional decoration of polystyrene cups, these are then put inside socks or stockings and tied to the CTD frame. On their return they have been pressurised and shrunk form about 5 inches in height to about 2 inches and all the writing and drawings shrink accordingly, its fun and a nice momento from these deep casts.

This is an extra CTD so there is even more sampling and water sloping around the filtering rigs than normal, lots more to process and new interesting views of the ocean as we have different water masses like the North Atlantic deep water and North Atlantic central that can be seen from looking at the salinity and other sensors on the CTD. Archived data from other cruises allow us to identify different water masses as they move about under the ocean from one ocean basin to another, it is quite amazing that all this goes on under the water surface. Samples are taken to try to capture a number of theses water masses to study their chemical make up and also their physical properties.

So ends another busy day and time to end this first long report.

Time is the big enemy out here, there is too little of it! After all the rushing around before sailing for a number of weeks, then taking such a battering in the channel and out to the Azores when just standing up was an effort, it comes to it that the most craved thing is sleep and so sadly the ideas that we would all try to write a daily commentary are quickly blown away by the tiredness of all of us. But we will do what we can.

Hello to all friends and family back on the solid stuff.

Blue deserts? – Friday 17th October 2008

On this vast deep blue slab of ocean, we have not seen any wildlife for days and it would appear on the surface that there is nothing out here except occasional white horses looming ferociously around the ship. Similarly the satellite ocean colour imagery that we receive daily from the National Earth Observation Data Archive and Analysis Service (NEODAAS) at Plymouth Marine Laboratory indicates that there is little phytoplankton in the surface layer of the ocean.

The Conductivity-Temperature-Density (CTD) trace operated by Dave and Terry and material from Chris's zoo-plankton net hauls, however, paint a different picture. Below us between 80 and 130 meters, there is broad peak in the fluorescence profile indicating higher phytoplankton at depth which peaks at 110 meters. The sample that Chris takes from his zooplankton nets is teaming with tiny marine animals. The zooplankton become food for fish, such as anchovies, which Stuart and Jo have been detecting in the backscatter signal. They continually graze the phytoplankton crop, but are rather 'sloppy feeders' and as they feast on the phytoplankton cells, they release proteins, amino acids and nutrients back into the water, which Malcolm, Carolyn and Paul are measuring. These released nutrients, in turn, become food for marine bacteria and small phytoplankton. This process is known as the microbial loop whereby large zooplankton feed on small zooplankton which in turn feed on small phytoplankton. These open ocean regions are so deep (>4.5km) that nutrient rich deep waters seldom reach the surface and the sunlit, upper ocean is fuelled by re-mineralized nutrients from grazing and breakdown of phytoplankton cells by zooplankton, bacteria and marine viruses. The system is a delicate balance between phytoplankton growth, zooplankton grazing and the release and re-mineralisation of nutrients. Any adverse affects on this tightly coupled chain, can have major consequences higher up the food chain on the fish and whales that graze either the phyto- or zoo-plankton.

The sunlight is so intense at these latitudes that if the small pico and nano-phytoplankton, such as Syneccococus and Prochloroccocus, are carried to the surface, they can explode due to the intensity of the visible and ultra violet light. They therefore reside at the deeper layers of the ocean, surviving on low light and re-mineralised nutrients. Chris characterises the light field daily at solar noon. Glen measures the abundance of these small phytoplankton groups using flow cytometry and Mike, Manuela and Ross are looking at which phytoplankton groups are using which nutrients. Vas, Mario and I are measuring the fixation of carbon through photosynthesis in these different phytoplankton groups and the respiration and O2 consumption of the communities. As the mixed layer deepens, these organisms and other organic matter gets sheared upwards into high light and can be photo-chemically transformed into different components, which are either transformed into other nutrient pools or released as gases. Some of these photo-chemical processes are what Vas, Paul and myself are measuring. These vast blue deserts occupy 70% of the world's oceans, and these tiny phytoplankton play a important role in maintaining the delicate food web that sustains life in these huge ocean 'deserts'.

Better turn in soon less than 6 hrs until I have to get up for the next CTD.

Stars in the sea – Sunday 19th October 2008

From the conductivity-temperature-density (CTD) profile yesterday it appears that we have moved out of the Northern Gyre and into more productive waters. Last night at 22:30 I saw from the ships bow a magnificent display of marine phosphorescence. As the ship ploughed through the waves, tiny star like formations appeared in the spray, like a neon, night sky in

the sea. This morning at the 04:00 CTD we saw squid and just after breakfast at 8:00a.m., a pod of 12 dolphins.

The sun is going down, so got to dash and filter my samples so they don't start respiring the carbon they have fixed during the day.

Calmer seas – Thursday 23rd October 2008

We have now moved from more productive waters back into oligotrophic conditions. The mixed layer has deepend to 60m, the deep chlorophyll maximum is sitting at 80m and just below the thermocline.

Today we spotted a single frigate bird and what was either a sunfish or turtle. The seas around the equator are calm and I looking forward to being rocked into a deep sleep before being abruptly awakened in less than 5hrs time for the next CTD.

Mario Vera, the POGO student – Thursday 23rd October 2008

Mario's first research cruise

Mario was the successful candidate from a good number of applicants from around the world who applied to be awarded the first Partnership for Observation of the Global Oceans (POGO)/AMT fellowship, the aim of which is to engage with those from developing countries and give the opportunity to learn new skills and to participate in an international research cruise. As I write we are about just 1 degree north of the equator so in fact not that far in relative terms from Mario's home in Bogota, Columbia. He has been a great colleague on board, always smiling, and is being taught English sayings (including some of the more mischievous).

Here is Mario's first blog…

In July 7 of the current year 2008, I was notified from Liz Humphreys (POGO secretariat) that I had been awarded the POGO-SCORE AMT fellowship for training in oxygen determination and experiments to ascertain the production –respiration ratio. It is hard to describe in words what I felt when I read for first time the notification – really? I could not believe it! A chance to participate in an AMT cruise is not small thing. Of course I applied for this fellowship in hoping to get it, but I knew, that many people (may be better qualified) were going to apply and that the probability to be chosen was very low. However, here I am, finally on the James Clark Ross; after two refused UK-visa applications and several problems finding a suitable flight ticket to be on time.

On September 5 after almost eighteen hours flying from Bogotá to Paris and then to London, I finally arrive in the UK. Once in the Heathrow Airport, I realize that my luggage was still in Paris, nice! Then after three and a half hours by train I arrived to Plymouth. It was 9:00pm and I was so tired, sweated, dirty and without luggage but in a good mood and very excited. The first person I met was my supervisor at Plymouth Marine Laboratory (PML), Dr. Vasilis

Kitidis (Vas). He took me to the house where I stayed before sailing – Dr Annie Linley's house. Annie also works in PML, she kindly offered a room in her house for my accommodation, I had a great time there and spent time during the weekends with her and her family.

On my first days in PML, Dr. Kitidis showed me the laboratories and introduced me to Malcolm Woodward who is the Principal Scientist and is also in charge of all the logistics and of measuring nutrients during the cruise. After completing some forms and formal documents I began with the training; some background reading on the production –respiration ratio issue was given to me and then Vas showed me the way to work in the laboratory, explained to me how the equipment function and then gave me some information about the technique to be used in measuring dissolved Oxygen in water: the modified Winkler technique.

The days after that and before the cruise, I spent my time practicing, doing the Oxygen measuring over sea water collected by PML and getting familiarised with the equipment and the problems that could arise during the measurements on the cruise. Then, after a few days of packing all the equipment and materials and approximately 7 funny and entertaining hours driving from Plymouth to Immingham, the Tuesday 30 of September we get on board of the research vessel RRS James Clark Ross.

Upon arrival, the Captain and his officers welcomed us and gave us some instructions and training about how to react to any potential emergency situation. A cabin was assigned to everyone; these are big enough to be comfortable, with internet connection, bathroom and fridge, also you have a nice view through the window. I share my cabin with Paul Mann "the man", a PhD student from the Newcastle University. He is studying the photo-degradation of dissolved organic matter.

The first day, when the ship was still in port; we, the people from PML and me were the first to get on board. We remained in the ship over three nights before the ship sails from Immingham. During these days we got familiarised with the inside of the ship; for some of us (specially to me) at first instance, to find a specific place on the ship was hard, it was like walking through a maze. Fortunately that is not a problem anymore.

Mario and the CTD

Now, that we are sailing, one realizes that nevertheless the travel on to the ship is very comfortable and funny, there is a lot of work to do during the day. Almost everyone have to be awake at 4:00am or earlier, in order to be on time to set ready the CTD or to take samples from it. The first day of sampling, in the early morning, at least five dolphins arose in the water, next to the ship, swimming very near to the CTD, they were there for 1h approximately, everyone on deck was trying to take a good picture but the light was not enough. One week later when we were heading to Azores islands, also a whale passed next to the ship but it disappeared after taking some air.

The time on the ship passes very fast, that is, fortunately, because there is much work to do; otherwise the trip, probably, would be boring. Almost everybody spends the whole day from laboratories or desks to the dining room and vice versa. The food and the service are, in my opinion, quite good and generally there is something new to try over the table. The free time is by general during the night, after work. More often than not almost everyone is at the bar chatting and having a drink or playing something like darts or cards. Usually, it can't take too long if you want to be ok the next day at 4am to be on deck sampling the CTD.

So far so good; now everybody is expecting for "Neptune" the king or the god of the sea (whatever) who, as far as I know from a secret informant, is going to come on board with big scissors and is going to cut off the hair of people who is crossing the line for first time. That is going to happen when the ship be over the equator line, but nobody knows with sureness if this story is real or just seamen fantasy! If you want to know what happen with Neptune and his scissor, keep watching the blog.

Equator crossed – Friday 24th October 2008

At 0102 hours this morning the RRS James Clark Ross and the AMT-18 team crossed the equator at 25 degrees West and headed into the Southern Hemisphere. A light swell and a starlit night welcomed us over.

Currently its 0530 and we are carrying out the first sampling CTD station of the day at 29 minutes south of the line.

Neptune no doubt still sleeping and dreaming of his visit later today.

Neptune Cometh to the JCR – Sunday 26th October 2008

After crossing the line very early of friday morning, the arrival of The King was delayed until 1530 to allow for scientific activities and also for Neptune to digest his lunch properly before all the excitement began.

Traditionally the 'unclean' ones. who have not crossed over into Neptunes realm. are know as 'Pollywogs' and those who have are the 'Trusty Shelbacks'. The sins of the Pollys are collected and a set of charges are put together, which they have the option to plead guilty or alternatively guilty. Either way they are stuffed!

Queen Neptune

Preparations were ongoing for a while leading up to this event with neptunes glamorous wife making herself particularly ravishing this year. The police force were recruited and all dressed rather fetchingly in blue overalls with smurf type headwear (still not sure of that) – these featuring Gavin, Paul Mann and also

Police and RoboCop

Bruce from the USA, who brought some marshall law to the proceedings. I was the Chief of Police, not that it was possible to control the rampant mob when we started hunting the pollywogs down. Oh yes, and Robocop made an appearance.

The captain, Jerry Burgan, welcomed Neptune and his entourage to the ship with the traditional welcome and all proceeded to the starboard side deck where the court had been set up. The Pollywogs, who had become an organised group over the last few days and with headbands defiantly displaying 'pollywog rebellion', all disappeared to hide from the trusty police force who were given their instructions before they were unleashed to hunt the sinners down. All the while

Manuela's judgement

Mr and Mrs Neptune waited, sipping tea and nibbling cakes. And so it was off around the ship – first to be found was Martin from Warwick Uni. He was well armed with water bombs, but a pincer movement soon had him under control and the yellow gaffer tape (yes we do have some left Prof. Liddicoat) had him bound up to avoid escape. Manuela was the first to reach the judge though and hear her crimes, she resisted but in the end was despatched according to custom.

The police were is a savage mood that afternoon but the Polly's put up, in some cases, an impressive struggle against superior forces. I am indeed still bruised from the repeated kicks from Jo as she was

Carolyn's punishment

wrestled down 3 flights of steps to the court by 5 of the police force. Carolyn was next to be tried fairly and found guilty of course. And so the sinners were caught one-by-one and dragged, some willingly and others not so, to the place of judgement. The actual court consists of the reading of the charges, these ranging from 'being Welsh' with Nerys the Doctor, to ' wanting breakfast in bed' from Mario our POGO student. On being found guilty, and of course the court is very fair, the barber cuts off the ceremonial lock of hair (would be difficult in my case!), and the gunge is applied as a punushment. Following that the doctor adminsters the medicine (9 parts tabasco, 1 part vegatable oil – see 'Delia cooks up a storm at Sea', page 47). After the medicine then they pay homage to Neptune and his lovely lady,

Kissing the kipper

which is done by 'kissing the kipper'. After the kipper then its off to the aft deck to be hosed down by the ships fire-hose, and my goodness do they need it! Jeremy from the Natural

History Museum in fact got ‘done’ twice as he would not shut up during the ceremony for the others. The deck of the JCR became, shall we say, a bit of a mess and the occassional resistance resulted in an innocent bystander being dragged through the gunge.

Never be last

So finally when all were caught and duly despatched there was one small late surprise for the newest of the engineers who had joined the ship direct from a cruise liner and had not time to get his ‘line’ certificate hence saving him from the court. So, basically stitched up by his officer colleagues poor Johnny was duly found guilty and ‘done’, but the rule is always ‘never be last’ because you get what’s left.

After many showers, and rumour has it that Mario was in the shower for 30 minutes as he still smelled of the gunge, and when all were smelling sweet again there was an on-deck dinner and a few beers to wash the taste away.

A great day, with thanks to the catering team and all who took part. Welcome to Neptunes Kingdom you Trusty Shelbacks !!

Parottnapping on the high seas – Monday 27th October 2008

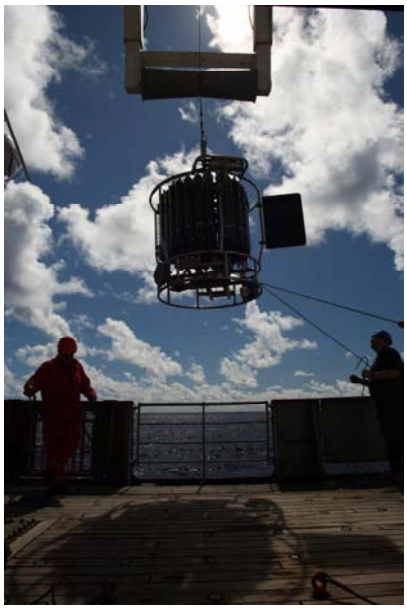
In a final desperate measure before meeting their judgement the dastardly Pollywogs Parotknapped the Nutrient Parrot. This chap is an old hand of 24 years at sea and far too many cruises to even start to discuss. The parott is/was cared for by the Chief of Police who is now quite distraught at this turn of events.

Poor Polly

However, despite this intervention he followed government guidlines and refused to negotiate with the terrorists who had taken the bird. Ransom posters were displayed and even after the event the parott has yet to be released. However it is now in the hands of the ships underground secret police led by Polly Mann who are confident they will find the bird and the criminals.

Any infomation please contact your local station, or ring Crimestoppers on 065346671882.

How to worry a Principle Scientific Officer – Tuesday 28th October 2008



Conductivity, temperature and depth profiler (CTD)

So here we sit here at 1000 local time, an hour behind you in the UK. Its a gently rolling sea with blue sea, blue skies (have you looked at the webcam?) and a very pleasant morning. We have carried out the regular 2 CTD's to 300m pre-dawn and today is one of the 2 deep CTD's that we will sample in the Southern Atlantic gyre region down to the ocean floor, a few thousand metres below the sea surface.

"How deep do you want to go", Terry asks. "Oh, 20 odd metres off the bottom will be fine, just as long as it's safe. Don't want to have to write a loss report to the Antarctic Survey, ho ho ho," I say, slightly nervously. This is their brand new CTD system heading to the Antarctic for the very first time so quite important for a lot of forthcoming science! So about 90 minutes later it's reached the bottom and we all came back to the readout screens to look at the salinity, temperature, oxygen etc. that will determine where we will fire the bottles for the water on the way back up.

The ships bottom read-out says 4380m and that also draws the ocean floor contours as we go along, quite interesting as it goes over sea-mounts and the like. "So what depth is the CTD", I ask. "4430m", says Terry. "What!! That's technically 50 metres below the ocean floor". A very nervous laugh from PSO, but Terry is happy that the depth is reading wrongly and the CTD is right, I just hope he/it is. But we really won't know for another 90 minutes. Oh err, feels like a good time for something stronger than coffee, now where is that bottle of Plymouth…

Physics on AMT – Thursday 30th October 2008

Since the beginning of the AMT, the programme was centred around optics, satellites and ocean biogeochemistry. It was this that established the AMT as one of the world's leading oeanographic programmes (and hence data sets), which we are now able to call 'long-term' as we enter this new phase with Oceans 2025 funding for the next 5 years. The big gap in our knowledge was always recognised as being the very limited ocean physics studies that were carried out during all the earlier cruises. However this has now been remedied to a large extent with the inclusion of the National Oceanography Centre (NOC) on-board team of Jo and Stuart, with invaluable help and guidance from John Allen up to the Azores. Although to be factually correct Jo has just started working at Proudman Oceanographic Laboratory (POL).

Jo and Stuart

The output is some excellent data which is near real-time and enables us to study the outputs from the Moving Vessel Profiler (MVP) and Acoustic Doppler Current Profiler (ADCP) to see what is going on in the water column and how that links to the chemistry and biology being studied in the main labs.

Colours in the sky – Friday 31st October 2008

Sky phenomenon

This morning it was quite overcast and with rain in the air, but with a couple blue patches poking through the gloom. On looking up we noticed this rainbow effect but very high up in the clouds, most strange. There was no rainbow before or after so a strange phenomenon…

Aqua-Technics – Saturday 1st November 2008

There are many instruments on board that we use to probe the mysteries of the ocean. From when we left Immingham to when we dock in the Falkland Islands, every minute of the day, 24 hrs a day, data is being collected along the ships track to assess the biological, physical and chemical properties of the ocean.

Perhaps the most important instrument that we use is the CTD which stands for Conductivity, Temperature and Density device. This is a stainless steel or titanium cage that houses temperature, conductivity (salinity), oxygen and fluorescence probes (phytoplankton biomass). At the top of the cage there is a transmissometer which measures the transmission of light through the ocean, a Fast Repitition Rate Flourometer which measures phytoplankton photosynthetic response and a pair of Acoustic Doppler Current Profiler (ADCPs) that measure particle backscatter to detect the size of particles in the water column. Around the perimeter of the cage there are 24 'bottles' that hold between 10 and 20 litres of seawater. Each bottle is a cylindrical, PVC tube with rubber sprung caps that close over the top and bottom end of the tube. The CTD is operated by Dave and Terry and lowered into the water from a winch operated by the ships crew. As it descends, the profiles of salinity, temperature, fluorescence, oxygen are plotted on a computer screen in the control room. From these plots, we decide where to collect water and as the CTD is winched back up through the water column, it is settled at a desired depth, and bottles are 'fired' or closed using a computer software interface to capture the water from that depth. On AMT18, we generally deploy the CTD 3 times a day to 300 meters just below the light zone; one at 4 a.m. when Carolyn, Paul, myself, Glen, Vas, Mario and Manuela collect water. Another at 5:30 a.m. from which Bruce, Martin, John, Jeremy and Martine sample and the third at 12:30 a.m. from which nearly everyone samples. On one CTD cast we normally collect water from about 16 depths. The water is then drawn from the bottles into sampling vessels by the

individual groups who perform an array of analyses from phytoplankton carbon fixation to genetic diversity (see blog entry 'Setting the scene'). We have also been doing some deep casts to 4500+ meters, which take about 4 hrs. From these, physicists Jo and Stuart and nutrient chemist, Malcolm are able to identify the different water masses present in the Northern and Southern Gyres (see blog entry 'The Atlantic Gyres'). During this cruise we will do between 100 to 120 CTD casts.

At the 4 a.m. CTD cast Chris also deploys bongo nets which have a 200 micrometer mesh used to 'fish' zooplankton. The net is deployed from the forecastle crane, early in the morning to capture the zooplankton which migrate closer to the ocean surface before dawn to feed on the phytoplankton. During the 12:30 CTD cast, Chris also deploys the optics rig which houses a number of instruments. There is a Fast Repetition Rate Flourometer (an FRRF) which flashes short pulses of blue light at the phytoplankton, which stimulates their photosynthesis causing them to emit a red "flash" back to the instrument. There is a WETLabs ac-9 which measures absorption (a) and attenuation (c) of the particles in the water column. Using these measurements we can measure the clarity of the water in the visible spectrum. There is also a Hobilabs backscatter meter which measures the backscattering of particles and a SATLANTIC UV sensor which measures the amount of ultra-violet (UV) light penetrating through the water column. To complement these, there are SATLANTIC radiometers (HyperSAS) on the bow and starboard mid-quarter which measure reflected light from the sea surface every 10 minutes. These data are used to sea truth satellite images. There is also a TRIOS UV sensor which records ambient UV. At the 12:30 CTD, Mike also deploys nets with mesh sizes ranging from 40 to 180 micrometers to capture micro-zooplankton (see blog entry 'Blue Deserts?').

When we are steaming between stations there are a number of instruments that continuously log data along the ships track. Towed behind the ship, is a Moving Vertical Profiler. This is a bomb shaped metal body that houses temperature, conductivity (salinity), oxygen and fluorescence sensors. As it is towed it undulates through the water column collecting profiles of these parameters. Terry and Dave spend a lot of their time monitoring and baby sitting the instrument, but it is worth it as the long track profiles they record are spectacular!!

Mounted on the hull of the ship, there is a larger Acoustic Doppler Current Profiler which uses a physical phenomenon called Doppler shift to measure how fast water is flowing. When a sound wave is reflected from something that moves, the frequency of the sound will shift slightly and from this shift in frequency Jo and Stuart can detect currents and also organisms.

Also mounted on the ships hull, there are several other types of acoustic instruments which were setup and running by Peter Enderlein & Co of BAS at the start of the cruise. The Multibeam echosounder maps the topography of the seafloor. The multibeam has transducers that both transmit and receive sound waves and send a cone of sound down to the seafloor, which reflects back to the ship. The returned echo is received by the transducer, amplified electronically, and recorded on graphic recorders. The time taken for the sound to travel through the ocean and back is then used to calculate water depths. The faster the sound waves return, the smaller the water depths and the higher the elevation of the seafloor. The EK60 echosounder estimates biomass and distribution of animals in the water column through backscattered sound waves. An Echogram from the EK60 echosounder, shows the distribution of fish and zooplankton in the water column as scattering layers.

Bruce has a neat array of instruments in his lab which are plumbed into the ships seawater supply. The seawater is sucked into the ship from the hull and flows into Bruce's ac-9 and backscatter meter (described earlier), which he uses to detect Coccolithophores, tiny calcite shelled phytoplankton.

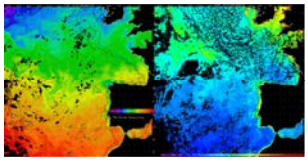
On the 'Monkey Island', the top deck of the ship, there is a meteoroligcal station recording wind speed and direction and ambient light. The University of East Anglia also have aerosol and particle samplers which are continuously collecting air particles from the atmosphere.

So even while I sit here in my cabin, tapping away at my laptop, a variety of data is being collected, which will hopefully reveal the secrets of the ocean.

Supported by satellite – Sunday 9th November 2008

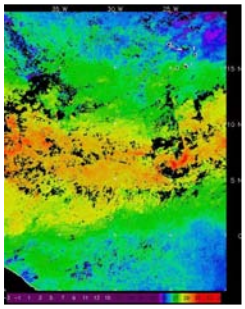
The measurements we make on the ship are not the only data that we use to improve our understanding of Atlantic Ocean Dynamics. The Royal Research Ship James Clark Ross receives satellite images each day from the National Earth Observation Data Archive and Analysis Service (NEODAAS) at Plymouth Marine Laboratory (PML).

High above our heads, circulating in the space, NASA and European Space Agency satellites carry sensors that scan the earth and continually measure the surface properties of the ocean. The main data that they collect, which we receive on the ship, are Sea Surface Temperature (SST) and Ocean Colour (Chl-a). Sea surface temperature is detected by infra-red sensors AVHRR (Advanced Very High Resolution Radiometer) on board the NASA satellite NOAA and NASA's MODIS (Moderate-resolution Imaging Spectroradiometer) SST. Ocean Colour is literally 'the colour of the ocean' derived from radiometers, such as MODIS (Moderate-resolution Imaging Spectroradiometer) and MERIS (Medium-resolution Imaging Spectrometer), which measure the reflection of light from the top 5m of the ocean and convert it into Chlorophyll-***a*** concentration, the photosynthetic active pigment of phytoplankton (the marine algae). These data are received by Dundee Satellite Receiving station, decoded and transferred to NEODAAS at PML, who process them into mapped images at 9, 4, 1 km or 500 and 300 meter resolution.



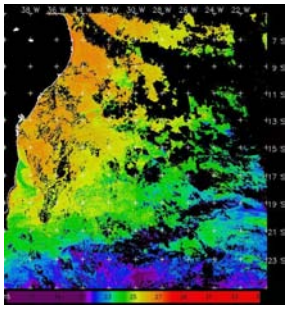
Sea surface temperature and ocean colour (Fig1)

During AMT18, we received some spectacular satellite imagery from NEODAAS. These AVHRR SST and MODIS-aqua Chl-***a*** images (Figure 1) show the transition from colder water (<14°C) with relatively high Chl-***a*** (>1mg m-3) in the North Atlantic to the warmer (>24°C) sub-tropical Atlantic water off the North coast of Africa with lower Chla (<0.07 mg m-3). Further South, MODIS-aqua SST showed warmer water (>29°C) at the tropical equatorial front between 5 & 10°N and equatorial upwelling south of 0°N indicated by the out cropping of water <25°C (Figure 2).



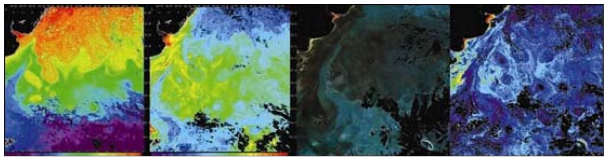
Sea surface temperature (Fig2)

In the southern Gyre, MODIS-aqua SST & Chl-a images indicated warmer water (>25°C) in the Southern Gyre and low Chla (<0.06 mg m-3) and colder water (<23 °C) with higher Chla (>0.07 mg m-3) to the south of the Gyre (Figure 3).



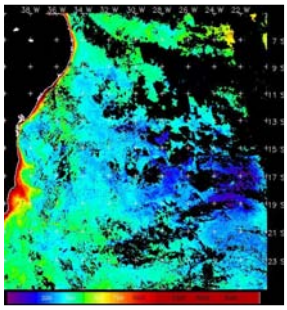
Sea surface temperature (Fig3)

In the South Atlantic, MODIS-aqua SST image showed the transition from warmer (>20℃) sub-tropical Atlantic water between 30 & 40℃S to the cold (~2℃) Antarctic overflow water south of 49℃S (Figure 4a). By comparison, MODIS-aqua Chl-a showed filaments of phytoplankton emanating from the Patagonian Shelf and the coast of South America (Figure 4b). This is partly due to calcite shelled phytoplankton known as Coccolithophores which can be detected easily as they are highly reflective, as seen in this image of sea surface reflection (Figure 4c). This image can then be processed into a calcite image, the Coccolithophores then show up as light green swirls entrained in ocean eddies off the Patagonian shelf, between Argentina and South Georgia as can be seen in this MODIS-aqua Calcite image (Figure 4d).



(Fig4a, b, c & d)

Other data can be calculated from the SST, Chl-a and Sea Surface Reflection data. The Remote Sensing Group at PML develop algorithms and models to derive more interesting parameters from the standard satellite data. They have algorithms capable of estimating phytoplankton primary production, or the amount of carbon fixed by the marine algae which is useful for climate change or fisheries studies. This image for example shows the primary production in the southern gyre where it is low (<200 mgC m-2 d-1) to the coast of South America where it increases to >400 mgC m-2 d-1 (Figure 5).



Primary production (Fig5)

Thanks to Rory Hutson, Jane Netting, Uvindu Perera and Peter Miller for Satellite Imagery Support during AMT18.

Port Stanley, Falkland Islands – Wednesday 12th November 2008

Views from Port Elizabeth

We arrived in Port Stanley at 10:00 a.m. on Monday 10 Nov. All of us tired and weary with the prospect of still having to pack our boxes of equipment into the containers. We eventually unloaded everything in the early evening which then gave us sometime to explore the town. It is spring in the Falklands and equivalent to May in the UK. My first impressions were it is windy, cold and barren place with low lying hills next to sweeping bays; something akin to the western isles of Scotland but colder. Stanley is a scattering of multi-coloured roofs sputtered against the shores of Port Elizabeth. There are just under 3000 people on the Falklands, 1800 of which live in Stanley. In the interior-countryside, people make a living from sheep farming. In Stanley there are 5 pubs, 1 restaurant, a couple of cafes, a couple of supermarkets, gift shops selling loads of tourist penguin memorabilia, a church, government building and swimming pool. My second impression is that most people in Stanley work in the service industry; the tourist trade must bring in a lot of revenue. Stanley is a small compact place. The people are very friendly and very patriotic; there are Union Jacks everywhere as a constant reminder of the Islands heritage and recent history.

Danger Mines: a constant reminder of the Falkland Islanders recent history

Outside Stanley the landscape is very much of upland heath capped with granite rock. The countryside is flat, barren and wind swept. There are no trees anywhere on the Islands, which means you cannot shelter from the almost constant buffeting winds. Sheep are scattered over this rugged terrain; the hardy Carradale's which have hats of wool covering their heads. By contrast to the stark landscapes, the Falklands is a wildlife haven; Striated Caracara, Turkey Vulture, Falcons and Eagles, Military Starling, Upland and Brent Geese, numerous duck to name but a few are abundant. There are still cordoned off areas with

active land mines and many war memorials; a constant reminder of the recent struggles that the Islanders have undergone.

Along the rugged coastline there are long stretches of sand, washed in aqua blue-turquoise surf. If you are lucky enough you may even spy black and white figures swaying and waddling over the dunes towards the beach like Sunday afternoon drunkards; Penguins!!! Some of the dunes on the north side of the island are littered with burrows excavated by Magellanic Penguins. These earthen homes hide curious heads which occasionally pop out of the sandy holes to reveal black and white eye patched faces characteristic of the species. Further over the dunes on the beach, colonies of Gentoo penguins abound. They are less shy than the Magellanics and the boldest amongst them are even curious enough to come close to humans. It's a fascinating place!!! Especially after being on a ship for 6 wks.
On Tuesday 11 November, I was still aboard RRS James Clark Ross, much to my annoyance. One of the instruments I had been using on the ship broke down early on during the cruise and on Tuesday morning at 8:30am I received a knock at my cabin door. It was the service engineer who had flown all the way from the UK to repair the instrument. By the end of the day I was relieved that the instrument was now working and giving sensible numbers. Over the next few days I will run a series of samples to check that the instrument was fully functioning again whilst the engineer was still in town. There are only two flights a week out of Stanley through an RAF flight to Brize Norton in Oxfordshire.

Natural History Museum Blog

Martine Couapel and Jeremy Young

This blog follows Museum researchers Martine Couapel and Jeremy Young as they collect minute plant plankton, called coccolithophores, in the Atlantic Ocean. They are taking part in the AMT18 (Atlantic Meridional Transect 18) oceanographic research cruise. It will take them from Britain to the Falkland Islands and will last 5 weeks.

The aim of their research is to build a more complete picture of the current distribution of coccolithophores in the Atlantic. Scientists are interested in finding out how coccoliths will be affected by global warming and by increasing levels of acidity in the ocean. Jeremy and Martine's research will provide baseline information about coccolithophores that future studies can be measured against.

We're off

Jeremy, Monday 6 October 2008

Our ship, the James Clark Ross

We're off. After several weeks of increasingly hectic shopping, and other preparations, we are now sailing down the English Channel (well actually we have stopped off at the Isle of Wight to practice sampling).

The photo below shows our equipment and supplies being winched onto the James Clark Ross. The pile looked very large as it was filling first Martine's office in the Museum then the car (in fact it only just fitted) but it looked minute on the quay next to the ship, and insignificant next to everything else being loaded onboard.

Our equipment being winched into the James Clark Ross

Winching equipment

The main reason the James Clark Ross goes south each year is to resupply the British Antarctic Survey bases and the ship is carrying tonnes of equipment and supplies for the scientists in the Antarctic. Mostly it is in crates but there is some pretty cool stuff on deck. In addition there is the party of eighteen scientists, including ourselves, for the slow cruise down to the Falkland Islands studying ocean life and processes as we go and they have a lot more equipment.

Once our little pile of gear had been put on the ship, we then had a day and a bit to unpack, set-up, and fix everything down securely – lots of drilling, screwing, and strapping. We also of course had to nip out and buy a whole lot more stuff, but we are now safely isolated from all shops so Martine will have to make do with whatever we have got.

Actually the shopping trip was curtailed by the need to get back for the safety lecture where we learnt what to do when the ship sinks (unlike the Titanic there are as many lifeboat places as people on board). Then on Friday, after one more lifeboat drill, we sailed out of Immingham docks (just next to Grimsby) and down through a surprisingly lively North Sea.

Leaving Immingham

Jeremy, The English Channel

Sampling

Martine, Monday 13 October 2008

Already a week since we left the stable land for the not-so-quiet sea. Time flies out here even though we have already gained 2 extra hours by sailing west, towards the sunset.

After a rough beginning of the week, the weather cleared up and the sea is more gentle now. We have settled into a sampling routine, usually with 2 sampling stations a day, one before dawn (unnaturally early according to Jeremy), the other at midday.

Sampling begins with the rosette sampler being lowered down through the upper 300m of water. It carries 24 bottles, each of which has an individual firing system to collect the seawater at specific depths.

The rosette sampler and other devices for recording water properties

Because the weather is now better, we can secure the rosette on the outside deck between samplings. This makes our life much easier when it comes to recovering the water. When the weather was rough, it had to be secured as soon as possible in its 'cabin' where it fits tightly, and half a dozen scientists would try to get in as well to recover their samples.

The rosette sampler returning to the deck at dawn this morning

After recovering the seawater, our main task is to filter it. We have to do this in several different ways depending on what we are trying to find out. First of all we look at a small syringe filter under the microscope to decide the volume of water to filter. We use membranes with holes that are 0.2 or 1 microns wide (a 10,000th of a centimetre) to filter the water. The process takes place in a vacuum and we use a recovering flask called a carboy.

While Jeremy set up the microscope in the dry lab, I played with tubing in the wet lab to set up our filtering system. Unfortunately our carboys were not delivered in time, so I tried (unsuccessfully) to use a fermenting cask. It collapsed. Then I tried a thick plastic flask. It also collapsed. We managed to borrow a 20 litre heavy duty carboy from Glen Tarran (a colleague from Plymouth). Fingers crossed, this one is still alive and healthy…

The sampler is relieved of its watery load

Because our 2 filtering ramps are on 2 different benches I had fun playing with tubing, connections and taps to connect everything. The best thing is that Jeremy loves to come and watch all the bubbly tubing!

We have now tried all our protocols and are ready for intensive sampling to produce LM (Light Microscopy) and SEM (Scanning Electron Microscope) slides, bulk and probe DNA samples, and other samples, during the second part of the cruise, south of the Azores.

A happy Martine surrounded by the filtration kit in her lab

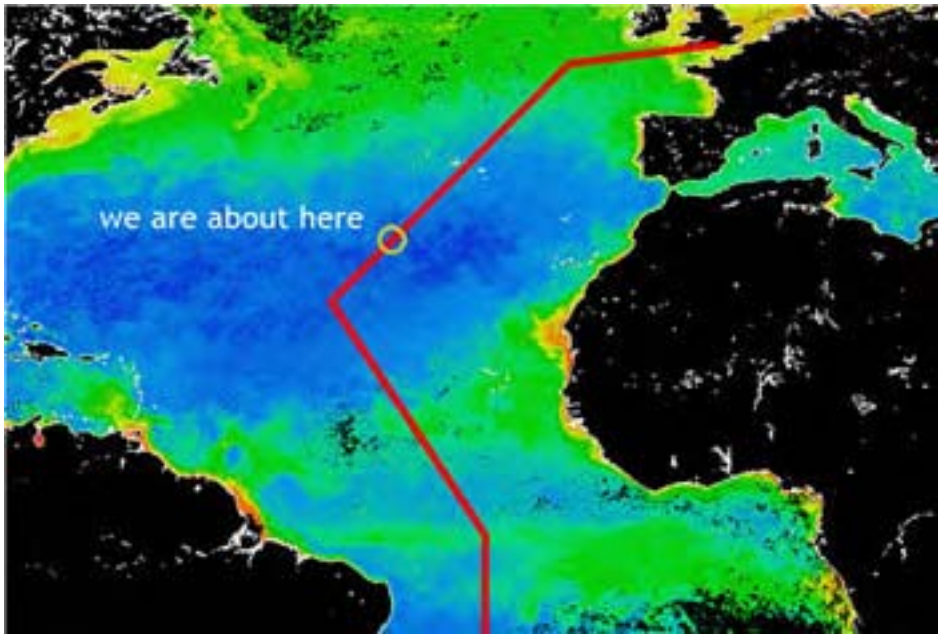
Martine, off the Azores

360 degrees of nothing

Jeremy, Wednesday 15 October 2008

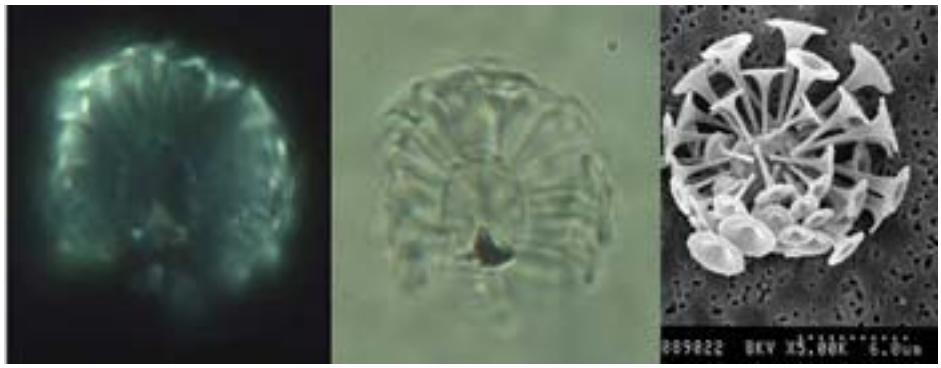
120 degrees of nothing, part of the view from Monkey Island

I am writing this from Monkey Island – the open space on top of the bridge where we can watch the world go by. And right now I am surrounded on all sides by absolutely nothing. There are no islands, no ships, no dolphins, no birds, just gently rolling dark blue water in all directions, except up. The complete absence of everything is because we have now got near to the centre of the North Atlantic gyre, which is one of the biggest marine deserts on earth.



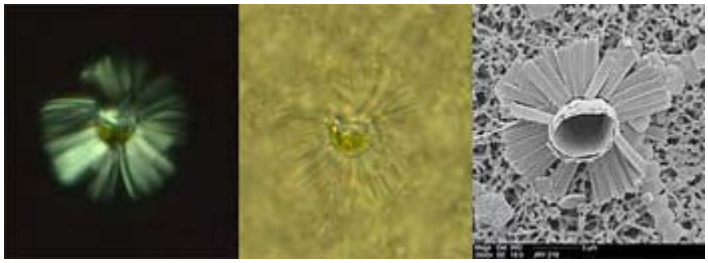
Middle of the desert – this satellite derived map shows the amount of plant pigment in the surface waters with maximum values shown in reds and minimum in dark blue. We are right in the middle of the North Atlantic desert.

Of course, unlike the Sahara desert, which is 2000 miles due east of us, there is no shortage of water here. But that water contains very, very little of certain key elements that life needs to grow, especially nitrogen and phosphorus (the same nutrient elements as I should be adding to my lawn back home to get the grass to grow a bit better next summer). Any trace of these elements in the water gets hoovered up by plant plankton.



Discosphaera tubifera – on the left is one of our favourite surface low productivity species, in the middle is the light micrographs taken today, and on the right is a scanning electron microscopy (SEM) image, taken several years ago.

Now, you would expect that the nice marine ecosystem would sensibly recycle these elements. However, the ecosystem is in fact hopelessly inefficient and when they die the plankton sink out of the water column taking the nutrients with them. So, the sunny wind-mixed top 60m or so of the ocean is almost lifeless.



Gladiolithus flabellatus – a very different coccolithophore specialised for low light conditions, this specimen was collected yesterday from 200m below the sea surface. The SEM image is of a specimen from similar conditions in the North Pacific.

Almost but not quite - some specialist plant-plankton have adapted to this harsh environment including particularly many of our friends the coccolithophores, the cacti of the oceanic deserts.

So, Martine's filtering is yielding a wonderful array of exotic specimens for the microscope. From the surface layers we need to pump several litres of sea-water to get enough to find on our filters. Deeper down, where the water is more nutrient-rich, different specialist forms adapted to low light levels occur at slightly higher abundances, although down there they have a range of things to compete with including cheerily-named cyanobacteria which several other people are studying on the cruise (more on them, the people not the cyanobacteria, another time).

My friend the microscope – an old one this, but a trusty travelling companion.

As we sail south each station has a slightly different water column structure and ecology. Observing the changing coccolithophore communities in the field is both a great way to ensure we get the possible results and extremely rewarding – coccolith heaven, I am back to the microscope.

Sunday news

Martine, Tuesday 21 October 2008

Sunday 19th October, 10 pm I'm outside by a nice clear night, writing from the hammock set up out of my cabin. It is the end of the weekend and there are not many people awake onboard… apart from Alex (the third mate) and Kevin (watchman) at the bridge to check there is nothing in our way and everything is working fine.

It's Sunday evening, however there is no real weekend onboard as we are sampling everyday. This weekend was especially busy with a deep sampling, down to 5150m on top of the normal 2 stations. We even ran out of containers to collect the extra samples and had to use the collapsed carboys.

Still just usable, one of the carboys we collapsed through vacuum pressure

This supplementary collection means for Jeremy and I about 290 litres of seawater filtered instead of the usual 160 litres per day, and about 20 extra slides to look at during the day… But it also means souvenirs as we sent down a team of expanded polystyrene cups attached at the top of the rosette sampler in socks (special thanks to Glen and Jeremy who provided the socks).

Preparing the important scientific experiment – cup-filled socks are attached to the rosette-sampler frame

At 5000m the pressure is about 600 times that at the surface and our valiant team was shrunk to a fraction of their previous size – this also meant that our swift marker-pen cartoons were rendered into finely detailed pieces of art.

Our cup team before and after meeting the AMT-Abyssal Challenge

Busy and fertile because most of the samples we collected over the weekend were really nice, and quite distinctive and thus worth having! We also had a nice barbecue-style party on the deck in the evening to relax and enjoy.

After dinner in the very dark night (no moon) some of us had the chance to observe bioluminescence (pictures to come later if we remember a camera next time) around the ship, the best observation spot was at the bow on the forecastle. The galley telegraph subsequently carried rumours of nocturnal entertainments near the kitchen (I've no idea what that was about, honest)…

Martine 11.13°N 32.06°W

Day in the life

Jeremy, Tuesday 28 October 2008

Dawn sky. Almost a nice sunrise this morning.

5.15 Alarm goes off, Martine and I have worked out we don't need to both get up early so we are alternating this, and unfortunately it is my turn for an early morning.

After getting up I nip across to the bar, conveniently just around the corner from my cabin, for a coffee. Then down to the lab where one of the Plymouth Marine Lab scientists, Carolyn, and chief scientist Malcolm, show me a large black insect that was found on the deck this morning. This is rather strange as we are more than a thousand miles from land.

Since I come from the Natural History Museum they hope I may be able to help identify it. It looks like a big black grasshopper to me; I take a set of photos and promise to ask an expert.

5.45 As I finally get to our corner of the lab the CTD and rosette sampler are still going down on its water collecting mission so I have time to wash and rinse our bottles and prepare the syringe filters we are using to take reconnaissance samples.

6.15 The CTD comes back on deck so it is time to collect the water – attaching hoses to the bottles on the sampler to fill up our jerry cans. This is really the only outdoor job we have so one of our favourite tasks. The sun comes up as we are sampling and a big frigate bird comes to visit, circling over the ship a few times.

6.45 Sampling over, it is back into the lab to do the syringe filter preps and start the main filtration process going.

7.30 Breakfast – a very welcome cooked breakfast (and more coffee), we are well looked after on the ship.

8.00 Start the main work of the morning: Processing the filter samples generated from the day before - we are collecting from 9 water depths in the morning and 13 in the afternoon.

There are two filters from each depth, as we are taking different filter types for light and electron microscopy, so there is a constant flow of filters to look after.

The filters for electron microscopy simply need to be transferred into petri-slides and labelled. For the light microscopy filters, I also make up microscope slides.

Part of the days haul of filters ready for storage. The square bits are where I have cut out a portion of the filter to mount for microsocpy.

9.00 Take a break to send an email to a couple of entomologists in the museum to ask what the grasshopper is. I can't remember who specialises in this group but I am very confident someone will know (especially as it is a big distinctive insect).

Then back to the microscope to check on the samples I collected this morning. We are near the equator now, the sea is getting more productive, and the coccolithophore communities are slowly changing – especially, and this is something of a surprise, the communities at intermediate depths around 50m.

Gryllus bimaculatus, our grasshopper stowaway.

10.00 Get an email reply from George Beccaloni explaining that our grasshopper is ‘an adult female Mediterranean Field Cricket, Gryllus bimaculatus. This species has a very wide distribution from Africa to Asia and it is also bred extensively in captivity for live food for reptiles etc, and as a lab animal. This species may have flown on board, but it may also be a stowaway. I had one recently brought in to the museum which jumped out of someone’s suitcase in the UK when they got back from Egypt.’

The fact that it is a common species is something of a relief, since Carolyn was very unhappy with the idea of me preserving him for the museum collections – a dragonfly which died on the deck a couple of days ago has ended up pickled in the fridge.

10.45 Reconnaissance of these morning’s filters is finished so I complete the sample labelling and take the trays down to the lab to start filling up with the next set of filters.

Start a more detailed examination of the afternoon filters from yesterday – the basic aim is to do a count of coccolithophore abundance in all the samples and note the dominant species but for the afternoon samples I am usually able to do a more detailed analysis.

12.00 Lunchtime – like I said they look after us well and lunch is a three course meal - with quite a bit of discussion of the grasshopper and other visitors. Then a half hour break for a relaxed coffee in the bar and a little wander round the ship.

The ship stopped after lunch for more sampling

12.45 Prepare for the afternoon sampling. Martine has decided that this is a good time for an extended sampling so we can collect bulk organic matter samples for DNA analysis through the water column. This means pressing all our bottles back into service.

After washing the bottles, time for a bit of a stroll and chat as the CTD goes out. The lunchtime (or more technically ‘solar noon’) halt is rather impressive as in addition to the

CTD midships there is a plankton net deployed further forward and an optics rig near the stern so with three cranes out, the ship looks like it is undertaking large-scale fishing.

13.30 The CTD comes out of the water and sampling gets back in earnest. With about 120 litres of water to collect there is a lot to do – and it is hot and humid outside.

The afternoon's haul of water (and it all needs to be filtered)

14.00 After half an hour of work in the sun the samples are safely lined up in the lab, and I am in severe need of a shower.

14.30 Back to the microscope to finish off the analysis of yesterday afternoon's samples – there is a lot of really nice stuff in the samples, but the day is getting a bit long and around this time I find microscope work pretty hard going; a bit of music helps and luckily there is an impressive system in the UIC (Underway Instrumentation Centre) where we have set-up the microscopes.

Our insatiable filtration set-up

16.00 Start my turn of the day's filter work. Filtering water is pretty much the coalface of oceanography and there is a lot of it going on on the ship. The basic principle is that you pour water into the top of the filtration apparatus it gets pumped through the filter and into a receiving carboy and the sample gets left behind on the filter.

So the filtering process basically involves pouring water in, ticking off how much has been filtered, watching till the water level falls near the bottom (running the filter dry is a bad idea), closing the tap, pouring in more, re-opening the tap and so on in (hopefully) a nice steady rhythm for as many hours as it takes to get all the samples done.

17.00 Science meeting – there are 18 scientists on board, and although we are in separate small teams, it is very useful to meet once a week or so to discuss plans for the next few

days sampling, and debate any interesting results (are low surface-water salinities here a result of Amazon outflow?). Today's meeting also includes a briefing on the crossing the line ceremony that is getting close and becoming a major focus of discussion.

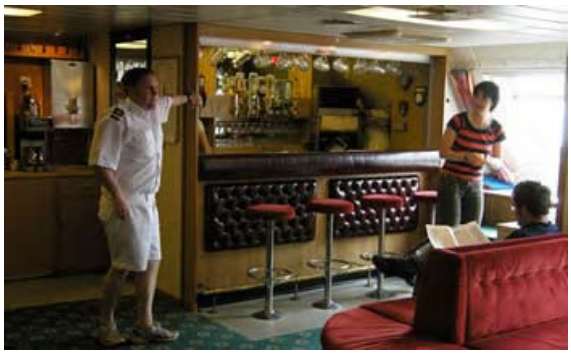
17.20 Back to the filtration – rather tranquil as the sun is low on the horizon and comes in through the lab windows, through which every now and then I can just about see a shoal of flying fish jumping out of the water.

Further away, there is less tranquility, as the engineering officers have got out their new inflatable swimming pool.

This is tempting but Martine and I still have a lot of work to do as a result of the extended sampling today.

18.20 Stop the filtration, change for dinner (no t-shirts or shorts allowed), and, as the sun is now definitely over the yardarm, its time for a medicinal G&T in the bar.

18.35 Dinner



The all important bar (and coffee machine)

19.30 Time for an after dinner coffee and chat in the bar – the bar has a bar, obviously, but it also has lot of comfortable seating space, tables, a darts board etc. and is the social centre for the scientists and officers (there is a separate crew bar which seems a touch anachronisitic but no-one on the ship wants to change that).

After dinner is probably the busiest time of day in the bar with most of us there, a lot of open discussion, and usually a group attempt at doing the crossword from the shipboard paper. Later on the numbers decrease as many people are working shift systems, or retire to their cabins, or like Martine and I tonight, have work to finish off.

20.15 Finish the last bit of filtering then spend an hour or so picking through the day's zooplankton sample for pteropods– this is a particularly pleasant and relaxing task which I will have to explain in another blog entry.

21.30 Rejoin the bar group for a wind down at the end of a rather longer than average day.

Jeremy, nearly at the equator.

Neptune's visit

Jeremy, Thursday 30 October 2008

As we continue inexorably southward days are beginning to merge into each other and we are going a bit stir-crazy. So any excuse for a change of routine is very welcome and last week we hit the biggest one, crossing the equator.

King Neptune and his lovely wife © Richard Turner

This happened on Thursday night and, as often happens at this latitude we were visited next day by King Neptune and his beautiful lady wife together with a retinue of judge, barber, doctor, and several policemen.

King Neptune's lackeys © Richard Turner

We were advised that various members of our party had been identified as 'pollywogs' - innocents who had not crossed the line previously and needed to be tried for crimes against Neptune.

Following time-honoured custom we then ran off to hide but were found one by one by the police and taken to the court for trial – where all the miscreants were found guilty, ceremonially shaved, given a few slops, injected with rather vile medicine, and invited to 'kiss the kipper'.

An attempted escape and recapture © Richard Turner

Jeremy having made little effort to hide was caught rather early on, judged to have been particularly disrespectful and punished for numerous misdemeanours, which was more or less fair. But, later he was given a second trial for heckling, which was a bit mean.

Jeremy meeting his fate © Richard Turner

Martine by contrast hid with supreme ingenuity and nearly escaped the process completely. However, she was eventually found and dragged to the court. Here she showed great aplomb but was found guilty of an exceptionally long and serious list of crimes (including being French and claiming to have crossed the line on a foreign ship) and got a well-deserved punishment.

Martine being dragged to court and punished © Richard Turner

The police then decided that one of their number, the electrician Johnie needed a little special treatment, as he had only previously crossed the line on cruise ships, which doesn't count. After that the pollywogs managed to turn the tables, staging a revolt and successfully chastising the doctor and various police.

Johnnie getting special attention © Richard Turner

Finally we rounded off with a bit of a party, which felt well-earned as we have been working more or less non-stop for the past three weeks, and to allow this the next morning's early station was cancelled.

Pollywogs revolting © Richard Turner

Apparently this is something of a tradition on AMT cruises and means that there is a bit of a gap in our data set just around the equator.

Jeremy and Martine, now in the South Atlantic

Representative objects

Jeremy, Tuesday 4 November 2008

We have worked our way across the southern Atlantic gyre sampling intensively as we went and have now left the tropics and run straight into a force 8 gale. This has stopped the science, so, there is finally time for us to catch up on the blog, starting with a little discussion of some objects representative of shipboard life.

The coffee carrier from the UIC

The coffee carrier: The “Underway Instrumentation Centre” (UIC) where our microscopes are based is a nice dry air-conditioned environment, in contrast to the warm and wet labs below. Along with the microscopes are computers controlling various machines, and scientists tending them. Now, scientists need coffee to sustain them and coffee comes from the bar one deck up and quite a way along (see photo of ship). Carrying cups of coffee by hand is a bad idea, since the ship rolls and a golden rule on board is one hand for the ship and one for yourself, i.e. you have got to have a free hand to hold onto the ship. So, one of the most useful pieces of kit in the UIC is the coffee carrier which allows us to transport cups of coffee in total safety – it may not look very clever but on a rolling ship a hanging tray works perfectly. It is also a nice example of the economy of ship-life. There are no shops around so making things yourself is the way to go, hence objects like biscuit tins, rope and copper piping get re-used and workmanship is valued (look at the neat way the ropes are tied off).

The RSS James Clark Ross, showing the relative positions of the bar and UIC

The scientist's beaker

The scientist's beaker: Along with improvised construction another way to get things on ship is by searching and borrowing, and people are remarkably generous in lending each other stuff. This beaker was leant to me by Paul Mann from the Plymouth team, and it filled a severe gap in the arsenal of multi-purpose objects I remembered to bring with me. The little chap next to it is also Beaker, from the Muppets, in honour of whom scientists on board ship are generally referred to as "beakers". So, our humble pyrex vessel is "the beaker's beaker" and hence arguably the smartest thing on ship.

Scones similar to those made by our doctor © Wikipedia

The doctor's scone: The ship also has an impressive range of human resources, including our very own doctor, Nerys, who is responsible not only for our well-being but also for the ship's official blog, or web diary. As part of her research for this she has been investigating the different parts of the ship, including the galley where she was put to work making scones. We had them for pudding at lunch recently. Very good they were too, just like my mother makes, or in the words of Alex (the third mate) marine-grade ballast scones.

Nerys' mother's crayons

Nerys' mother's crayons: Martine, I and the other scientists will be leaving the James Clark Ross when we get to the Falklands in a week or so. The officers and crew will be staying for three more months till the mid-cruise crew change. So our lovely doctor, Nerys, will be the only person staying on the ship until it returns to England in May. Which means she is away from home for eight months. Her mother was obviously concerned about this and has given her a series of date-marked parcels to open at Christmas, New Year and other such important dates, as the cruise progresses. Yesterday was the 31st of October and Nerys had a parcel containing, hallowe'en chocolates, a witch's hat, and a set of face-paint crayons. The crayons looked innocuous but they provided the catalyst for some flamboyant artwork.

Evidence of the talent and ingenuity aboard: from left to right, Vas Kitidis (scientist), Nerys Lewis (doctor), Ben Tullis (the ship's IT specialist), Mike Gloistein (Radio Officer), Paul Mann, Mario Vera and myself

Jeremy, South Atlantic

Storms, albatrosses and our own CTD cast

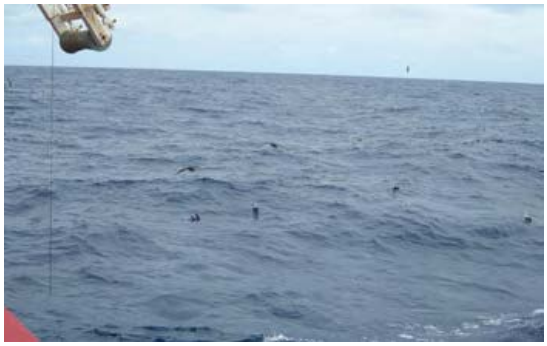
Jeremy, Wednesday 5 November 2008

It's Sunday 2nd November now, so only another week of the cruise, which is maybe just as well since we are running low on supplies for sampling, boxes to put them in, microscope bulbs, and energy. As we left the tropics we ran into a gale and a big swell, which set the ship rolling quite nicely and resulted in two of our sampling stations being cancelled – which was a bit disappointing but it did allow us to stop work and enjoy the sea. Standing on monkey island (i.e. above the bridge), as the ship rose in and out of big waves was very impressive. Then as a bit of a bonus our first albatross appeared.

Going through the gale - the James Clark Ross hitting a wave relatively firmly

The first albatross we have seen on the cruise

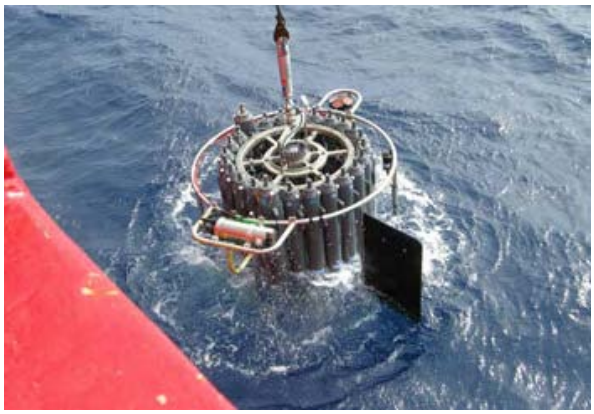
Generally the number of birds is increasing as we leave the tropic and go into more fertile waters. The weather improved today and at lunchtime we were able to stop for our noon sampling station in relatively calm sunny waters and slowly gathered a little flock of petrels and albatrosses. Indeed albatrosses are beginning to get positively common.



Numerous birds watching the lunchtime water-sampling

Another albatross

Scientifically today was rather special for us. One of our prime objectives on the cruise has been to study the change in distribution of coccolithophore populations with depth. Our observations so far have suggested that, rather than there being separate near-surface and deep communities, there is a continuous succession of different assemblages with depth. Luckily for us there was also some ship-time available for additional science and the principal scientific officer, Malcolm Woodward, was able to arrange a separate CTD sampling mission for us. So, today after the regular noon sampling the ship stayed on station for another hour or so as the CTD and rosette sampler was sent back down for a special Natural History Museum sampling mission, collecting water every 12 metres from 275m to the surface. This means a late night beckons as we work our way through 260 litres of seawater.



Up it comes again, the sampler, this time with water just for us

Jeremy and Martine – 33°S 31°W

Land ahoy

Jeremy, Tuesday 11 November 2008

Nearly over. After six weeks the cruise has ended, at least as far as we are concerned. We have got to the Falklands safely and docked at Port Stanley. The Falkland Islands invite rather mixed comments on ship but they looked beautiful in the early morning sun as we

arrived, and to remind us of the naval history a frigate was anchored in the entrance to the sound.

Heading towards the Falklands

HMS Iron Duke in front of Mount Tumbledown

The last few days have been rather dominated by weather as we have gone through a series of gales alternating with calm sunny intervals. The sunnier intervals allowed some sampling in these waters and we have been rewarded with green soupy water rich in diatoms, copepods, some rather unpleasant gelatinous gunge and a few whales.

A whale's tail

Coccolithophores have remained common and surprisingly diverse but the layers of different populations are no longer distinct – they now look pretty similar throughout the water column.

The zooplankton samples have been interestingly variable. Plankton net sampling has been cancelled several times but the samples which did come in made a very useful addition to the material I have been collecting.

However, science stopped completely a couple of days ago so that we could get packed before arriving in the Falklands. The first task was tidying up and sorting out the samples.

There is a decent haul – we have collected from about 70 stations and accumulated about a thousand filter samples, four hundred microscope slides, eighty bulk organic samples for DNA analysis, two hundred filter samples prepared with a special buffer to allow labelling of cells with fluorescent markers, and hundreds of pteropods and ostracods picked from the zooplankton.

After that the main dismantling of the labs and packing up took place on Saturday afternoon, just as we hit particularly bad weather. To make things worse we were sailing south whilst the wind and waves were coming from the west, which made for rather chaotic ship motion and the occasional spectacular roll of up to 30°. So packing was sporadically interrupted by the need to grab something solid with one hand while restraining what ever one was trying to pack with the other hand. The rolling also added a certain something to the end of cruise dinner, and especially to the dancing in the crew bar.

A wash bottle serving as an inclinometer to record the ship's motion, although I did not manage to photograph it during any of the larger rolls

So that is about it for the cruise, although we will have a lot of work to do on the samples over the next few months. It has been a great experience, we have learnt an immense amount and had some excellent evenings. The RRS James Clark Ross is a fine ship and everyone from galley staff to the captain has made us welcome. It's nice to see dry land but we will be sorry to say farewell to the ship.

Jeremy & Martine, Port Stanley.

POGO-SCOR AMT Visiting Fellowships for 2008

Special Opportunity for On-board Training during an Atlantic Meridional Transect Cruise

The Partnership for Observation of the Global Oceans (POGO) and its partner, the Scientific Committee on Oceanic Research (SCOR), offered a special opportunity in 2008 for on-board training during the Atlantic Meridional Transect Cruise, in partnership with the Plymouth Marine Laboratory, within the POGO-SCOR Fellowship Programme for 2007-08. This programme is designed to promote training and capacity building leading towards a global observation scheme for the oceans.

Background

At the POGO-2 meeting, the participants endorsed the São Paulo Declaration, which called for enhanced observations in the Southern Hemisphere. In response to the call, and as part of their 30th Anniversary celebrations, JAMSTEC organised the circum-polar cruise in the Southern Hemisphere, named the Blue EArth GLobal Expedition (BEAGLE) Expedition. A hallmark of the expedition was the manner in which many oceanographic institutions of the Southern Hemisphere were invited to participate as partners in this major initiative. Another hallmark was the opportunity that JAMSTEC provided for training up to 3 oceanographers from developing countries on each leg of the expedition. POGO, IOCCG and IOC organised the training programme on the BEAGLE expedition, with guidance and much help from the JAMSTEC scientists. This allowed for training 18 oceanographers on the BEAGLE expedition. Another remarkable aspect of the BEAGLE Expedition is that it allowed for the inclusion of bio-optical observations; the bio-optical programme was executed by a team of scientists from POGO member institutions and Southern Hemisphere partners.

Following this undoubted success, POGO offered another targeted on-board training opportunity on the Atlantic Meridional Transect (AMT), building on the BEAGLE experience and inspiration. The Atlantic Meridional Transect (AMT) programme (Aiken and Bale, 2000; Aiken et al., 2000; www.amt-uk.org) began in 1995, utilising the passage of the ***RRS James Clark Ross*** through the Atlantic Ocean, between the UK and the Falkland Islands (50^{o}N to 52^{o}S, a distance of over 13,500 km) southwards in September and northwards in April each year. The transect crosses a range of ecosystems from sub-polar to tropical and from eutrophic shelf seas and upwelling systems to oligotrophic mid-ocean gyres. The scientific aims included an assessment of mesoscale to basin -scale phytoplankton processes, the functional interpretation of bio-optical signatures and the seasonal, regional and latitudinal variations in mesozooplankton dynamics. The programme provided a platform for international scientific collaboration, including the calibration and validation of SeaWiFsS measurements and products. The measurements of hydrographic and bio-optical properties, plankton community structure and primary production completed on the first 12 transects (1995-2000) represent the most coherent set of repeated biogeochemical observations over ocean -basin scales. This unique dataset has led to several important discoveries concerning the identification of oceanic provinces (Hooker et al., 2000) validation of ocean colour algorithms (Hooker and McClain, 2000), distributions of picoplankton (Zubkov et al., 2000), identifying new regional sinks of pCO_2 (Lefevre et al., 1998) and variability in rates of primary production (Maranon et al., 2000) and respiration (Serret et al., 2001).

In 2001, the programme restarted (2003-2005; Table 1) and broadened, to address a suite of cross-disciplinary questions concerning ocean plankton ecology and biogeochemistry and their links to atmospheric processes. The objectives included the determination of how 1) the structure, functional properties and trophic status of the major planktonic ecosystems vary in space and time; 2) physical processes control the rates of nutrient supply, including dissolved organic matter, to the planktonic ecosystem; and 3) atmosphere-ocean exchange and photodegradation influence the formation and fate of organic matter, and were to be addressed by more than 45 scientists from 6 UK research institutes participated in these cruises.

Between 1995 and 2008, the programme has included 18 research cruises, involving ~180 scientists from 11 countries, contributing to 180 refereed publications and 68 PhD. Theses. This unique spatially extensive decadal dataset continues to be deposited and made available to the wider community through the British Oceanographic Data Centre (www.bodc.ac.uk).

The third phase of the AMT programme (5 cruises between 2008-2012) has now been approved, and mechanisms are being explored to maintain the programme as a long-term multi-disciplinary ocean observation programme, 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.

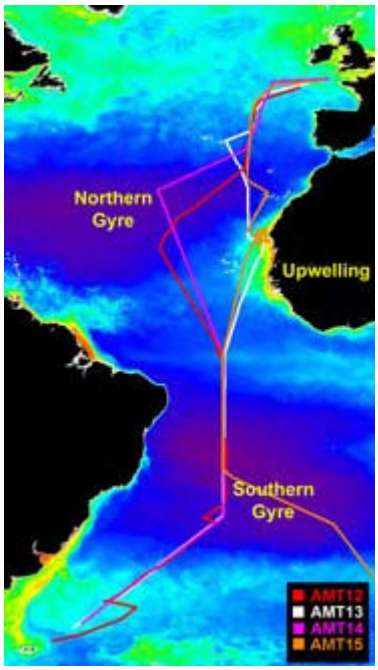


Fig. 1: Cruise tracks of AMT 12, 13, 14 & 15.

Applicants

The fellowship program was open to scientists, technicians, graduate students (PhD) and Post Doctoral Fellows involved in oceanographic work at centres in developing countries and countries with economies in transition. The participants were selected on the basis of applications submitted. There were 14 applications (in addition to some 4 incomplete) ones for one berth on the AMT cruise. The initial screening of the applications was made by a small AMT team, on the basis of feasibility of proposed training, taking into account facilities and expertise available. They then made its recommendations to a POGO-SCOR Selection Committee. In their decision-making, the Selection Committee considered the following criteria:

1. Quality of the application;
2. Relevance of the application to the priority areas identified in the Fellowship Announcement;
3. Evidence that the training will lead to improved sustained observations in the region, or improved applications of such data;
4. Evidence that the training will lead to capacity-building with potential lasting impact on regional observations; and,
5. The need to maximise regional balance in distribution of the awards.

The selected candidate in 2008 was Mr. Mario Felipe Vera Sierra, a master's level post-graduate student from the Universidad de la Republica (Uruguay), who applied to work on

Dissolved Oxygen and Plankton Community Production – Respiration in the Atlantic Ocean under the supervision of Dr. Vassilis Kitidis (PML).

Scope of the Fellowship

The Fellowship provides opportunity for selected candidates from developing countries to participate in the AMT cruises. The selected candidates will have the opportunity to visit Plymouth Marine Laboratory for one month prior to the start of the cruise to learn about cruise preparation and planning; to go on the cruise (~ 35 days) and participate in making hydrological, bio-optical and ecological observations; and on completion of the cruise, to spend two additional months at PML, learning to analyse the results statistically and interpret them. Subject to future funding, core measurements are planned to include phytoplankton, zooplankton and bacterioplankton diversity, pCO_2, O_2/Argon/dimethyl sulphide, fast repetition rate fluorometry, optics, coloured dissolved organic matter (CDOM), pigments and micromolar nutrients, with additional process oriented measurements on 3 cruises to include ^{14}C PPprimary production, excretion, respiration, gross production, ^{15}N new production, bacterial production, DOC dissolved organic carbon, nanomolar suite of nutrients, CDOM bleaching and molecular diversity.

The terms of the Fellowship

1. The fellowship provides international airfare and subsistence allowance for the fellowship period (the actual amount will be tailored to meet local conditions, but will not exceed US $ 1,300 per month).
2. The trainee's institute bears all expenses incurred by the fellow in his/her own nation (domestic travel, visa costs, etc.), and the host institute will waive any bench fees that they may normally charge trainees.
3. POGO does not cover any of the expenses related to the training itself.

Post training Reports

The reports submitted by the trainee Mr. Mario Felipe Vera Sierra and his parent supervisor Dr. Danilo Calliari from the Universidad de la Republica (Uruguay), and the host supervisor Dr. Vassilis Kitidis (PML, UK) have been uniformly positive, and strongly recommend the continuation of the training programme into the future. All concerned parties recommend that the selection process be completed some six months prior to the cruise, in view of difficulties and lengthy procedures associated with procuring visa to the UK. Therefore ideally, the AMT Fellowship Announcement will go out in January along with the announcement of the regular fellowship programme, with a deadline in April, and decisions in May.

Dr. Andy Rees (coordinator, AMT programme), is also strongly supportive of continuing the programme into the future, and has reserved a berth for a trainee on the 2009 AMT programme.

Scientific Cruise Reports

Primary production and photo-oxidation of coloured dissolved organic material

Dr. Gavin Tilstone
Plymouth Marine Laboratory, West Hoe, Plymouth PL1 3DH, UK. Email; ghti@pml.ac.uk

OBJECTIVES

Integrated Primary production measurements were made at 29 stations on three size classes of phytoplankton during AMT18. 140 measurements of the absorption coefficient of coloured dissolved organic material from 250 to 800nm ($a_{CDOM}(250\text{-}800)$) were also made at 35 stations and 17 CDOM photo-oxidation experiments were conducted in which CDOM was exposed to dark, UV and visible light for varying periods to measure changes in the spectra. These measurements aim to fulfil the following objectives within Oceans 2025:

- ***The main deliverable of Theme 10a, AMT is to provide an unique time series (1995-2011) of spatially extensive and internally consistent observations on the structure and biogeochemical properties of planktonic ecosystems in the Atlantic Ocean that are required to validate models addressing questions related to the global carbon cycle. One of the key parameters is phytoplankton production. To this end a continuous long track series of primary production measurements have been made on AMT18 using methods synonymous to those used in previous AMT cruises.***
- ***As part of Theme 2 key rates of climatically important microbial and photochemical processes will be measured. These will include the photo-degradation of dissolved organic material.***

METHODS

Primary production

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

CDOM absorption coefficients ($a_{CDOM}(\lambda)$). Seawater samples from 4 to 8 depths in the water column were filtered through 0.2 µm 25mm Whatman Anodisc filters using acid cleaned

glassware. The first two 0.25l of the filtered seawater were discarded. The absorption properties of the third sample were determined in an 10 cm quartz cuvettes from 350 to 750 nm relative to a bi-distilled MilliQ reference blank using a Perkin Elmer Lambda 35 spectrophotometers. $a_{CDOM}(\lambda)$ was calculated from the optical density of the sample and the cuvette path length. The slopes (S_{CDOM}) of $a_{CDOM}(350\text{-}650)$ and $a_{CDOM}(250\text{-}650)$ were calculated using an offset exponential fit which corrects for water absorption effects >700 nm following the methods outlined in ***Tilstone et al.*** (2004).

The Effect of UV on the absorption of Coloured Dissolved Organic Material (CDOM)
30litres of sea water was taken from the surface, bottom of the mixed layer or 3000mts at 17 stations to determine whether UV has an effect on CDOM. The seawater was sequentially filtered through 0.2 & 0.1 μ Acropak PALL filters into 1 litre quartz or glass flasks which were exposed to the following treatments in solar simulators: 1.) PAR only; 2.) PAR + UVA + B; 3.) Dark. $a_{CDOM}(250\text{-}800)$ was determined at the start of the experiment (T0), after 6 h (T1) and 24 h (TF) on replicate water samples for each treatment to assess the effect of UV on $a_{CDOM}(\lambda)$.

Table 1. Stations at which primary production, HPLC phytoplankton pigments, $a_{CDOM}(\lambda)$ and $a_{CDOM}(\lambda)$ photo-oxidation measurements were made.

CTD No.	Date	Time In water GMT	Lat	Long	depths (m)	Measurements taken†
002	06 Oct	05:50	49° 28.92'N	09° 50.76'W	2, 25, 40	CDOM
002	06 Oct	05:50	49° 28.92'N	09° 50.76'W	10	CDOM photo-ox T0, UV, VIS, Dark, TF(5hrs)
005	07 Oct	05:24	49° 08.95'N	14° 39.15'W	2*, 6*, 12, 21*, 37*, 49, 73	PP size fractionated, CDOM*
005	07 Oct	05:24	49° 08.95'N	14° 39.15'W	6	CDOM photo-ox T0, UV, VIS, Dark, TF(5hrs)
008	08 Oct	05:15	46°35.44'N	18°41.79'W	2*, 7, 13, 23*, 41, 54*, 81, 200‡	PP size fractionated, CDOM* CDOM only (no PP) ‡
0011	09 Oct	05:15	42°40.37'N	22°11.69'W	2*, 12, 22, 40*, 72, 95*, 143*, 200‡	PP size fractionated, CDOM* CDOM only (no PP) ‡
0011	09 Oct	05:15	42°40.37'N	22°11.69'W	12	CDOM photo-ox T0, UV, Dark, T1, TF
0013	10 Oct	05:15	38°52.91'N	25°19.45'W	2*, 24, 43, 60*, 78, 153*, 300‡	PP size fractionated, CDOM* CDOM only (no PP) ‡
0015	11 Oct	05:15	36°00.19'N	27°44.24'W	2*, 30, 55*, 74, 98, 129*, 193*	PP size fractionated, CDOM*
0015	11 Oct	05:15	36°00.19'N	27°44.24'W	55	CDOM photo-ox T0, UV, Dark, T1, TF
0018	12 Oct	05:15	33°17.88'N	30°47.82'W	2*, 21, 37, 50*, 67, 88, 110‡¤, 132, 300‡	PP size fractionated, CDOM* CDOM only (no PP) ‡ HPLC Chla max only (no PP)¤
0021	13 Oct	05:15	30°28.35'N	33°57.07'W	0*, 27, 40‡, 48, 65, 86, 113*, 170, 300‡	PP size fractionated, CDOM* CDOM only (no PP) ‡ HPLC Chla max only (no PP)¤
0021	13 Oct	05:15	30°28.35'N	33°57.07'W	40	CDOM photo-ox T0, UV, Dark, T1, TF
0024	14 Oct	05:15	27°37.89'N	37°01.83'W	2*, 31, 55*, 74, 98, 120¤, 129*, 193, 300‡	PP size fractionated, CDOM* CDOM only (no PP) ‡ HPLC Chla max only (no PP)¤
0027	15 Oct	05:18	24°44.66'N	40°05.30'W	0, 27, 49, 66, 87, 115, 172	PP size fractionated

0029	15 Oct	05:18	24°44.66'N	40°05.30'W	2, 40, 120, 850, 1335, 2000, 3000, 4690	CDOM only
0029	13 Oct	05:15	24°44.66'N	40°05.30'W	3000	CDOM photo-ox T0, UV, Dark, T1, TF
0031	16 Oct	05:18	22°35.98'N	40°15.94'W	0*, 30, 50, 72, 95, 124, 187, 60‡, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡
0034	17 Oct	05:18	19°43.34'N	38°13.80'W	0*, 28, 50, 66, 88, 110, 173, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡
0037	18 Oct	05:18	16°48.64'N	36°12.40'W	0*, 24, 43, 58, 76, 100, 150, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡
0037	18 Oct	05:18	16°48.64'N	36°12.40'W	0	CDOM photo-ox T0, UV, VIS, Dark, T1, TF
0039	18 Oct	08:40	16°48.64'N	36°12.40'W	315, 340, 500, 1000, 2000, 3000, 4000, 5260	CDOM only (no PP)
0041	19 Oct	05:17	14°55.15'N	34°55.32'W	0*, 21, 37*, 50*, 66, 87, 130*	PP size fractionated CDOM*
0044	20 Oct	05:17	11°49.24'N	32°49.44'W	0*, 8, 15*, 27, 37, 50*, 64, 96*	PP size fractionated CDOM*
0044	20 Oct	05:17	11°49.24'N	32°49.44'W	15	CDOM photo-ox T0, UV, VIS, Dark, T1, TF
0047	21 Oct	05:17	08°38.63'N	34°55.32'W	0*, 21, 37*, 50*, 66, 87, 130*	PP size fractionated CDOM*
0050	22 Oct	05:17	05°20.39'N	28°31.27'W	0*, 19, 34, 46*, 60, 70‡ 79, 118, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡ HPLC Chla max only (no PP)¤
0050	22 Oct	05:17	05°20.39'N	28°31.27'W	46	CDOM photo-ox T0, UV, VIS, Dark, T1, TF
0055	23 Oct	05:17	01°47.45'N	26°51.23'W	0*, 19, 34, 46*, 60, 70‡¤ 79, 118, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡ HPLC Chla max only (no PP)¤

0058	24 Oct	05:17	00°35.13'S	24°59.82'W	0*, 24*, 43, 58*, 76, 100, 150*	PP size fractionated CDOM*
0058	24 Oct	05:17	00°35.13'S	24°59.82'W	24	CDOM photo-ox T0, UV, VIS, Dark, TF
0062	26 Oct	05:15	08°49.52'S	24°59.72'W	0*, 25*, 45, 60*, 80, 105, 159*, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡
UW / CTD063†	26 Oct	20:00	08°49.52'S	24°59.72'W	0	CDOM photo-ox T0, UV, Dark, O2, CO2, TF
0065	27 Oct	05:15	12°50.38'S	24°59.89'W	0*, 25*, 45*, 60, 80, 130*, 157, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡
0068	27 Oct	05:15	12°50.38'S	24°59.89'W	0	CDOM photo-ox T0, UV, VIS, Dark, TF
0069	28 Oct	05:15	16°38.26'S	24°59.65'W	0*, 32, 58*, 78, 103*, 145, 203, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡
0071	28 Oct	07:30	16°38.26'S	24°59.63'W	530, 1000, 3000, 4530	CDOM only (no PP)
0074	29 Oct	05:15	19°07.41'S	24°59.75'W	0*, 30, 53, 72, 95, 125*, 145, 175‡¤, 187, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡ HPLC Chla max only (no PP)¤
0078	30 Oct	05:15	22°47.12'S	25°00.54'W	0*, 30, 40‡, 53, 72, 95, 140*, 187, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡
0078	30 Oct	05:15	22°47.12'S	25°00.54'W	0	CDOM photo-ox T0, UV, VIS, Dark, TF
0082	31 Oct	05:15	26°33.44'S	24°59.87'W	0*, 31*, 55, 74, 97, 128*, 192, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡
0084	31 Oct	08:30	26°33.44'S	24°59.87'W	800, 1300, 2000, 3000, 4571	CDOM only (no PP)
0084	31 Oct	08:30	26°33.44'S	24°59.87'W	3000	CDOM photo-ox T0, UV, Dark, T1, TF
0086	01 Nov	05:15	28°52.09'S	26°02.17'W	0*, 26, 47*, 63, 84, 110*, 165, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡

0088	02 Nov	14:45	32°10.77'S	29°49.53'W	0, 60, 90, 300	CDOM only (no PP)
0090	03 Nov	06:21	33°46.09'S	32°00.18'W	0*, 9, 30*, 41, 54*, 71, 105*	PP size fractionated CDOM*
0090	03 Nov	06:21	33°46.09'S	32°00.18'W	54	CDOM photo-ox T0, UV, Dark, T1, TF
0093	04 Nov	05:18	36°10.39'S	35°03.25'W	0*, 8, 27, 37*, 49, 65, 98*, 300‡	PP size fractionated CDOM* CDOM only (no PP) ‡
0096	05 Nov	05:22	37°58.07'S	37°24.76'W	0*, 6, 21, 29*, 38, 50, 76*, 200‡	PP size fractionated CDOM* CDOM only (no PP) ‡
0096	05 Nov	05:22	37°58.07'S	37°24.76'W	29	CDOM photo-ox T0, UV, Dark, VIS, T1, TF
0090	03 Nov	06:21	33°46.09'S	32°00.18'W	0*, 9, 30*, 41, 54*, 71, 105*	PP size fractionated CDOM*

Results

During AMT18 primary production (PP) varied by nearly two orders of from 38 mgC m^{-2} d^{-1} in the Southern Gyre to 3413 mgC m^{-2} d^{-1} on the Patagonian shelf (***Figure 1***). In the North Atlantic Drift Province (NADR, >40°N) the average PP was 192 mgC m^{-2} d^{-1} and 50 % of the production was attributed to picophytoplankton, 34 % to nanophytoplankton and 16 % to microphytoplankton. Similarly in the Western Tropical Atlantic (WTRA, 10°N to 5°S) the mean PP was 206 mgC m^{-2} d^{-1} but 63 % of the production was attributed to picophytoplankton, 16 % to nanophytoplankton and 21 % to microphytoplankton.

In the North Atlantic Sub-Tropical Gyre (NATL, 40 to 10°N), the mean PP was lower ~145 mgC m^{-2} d^{-1} and the contribution of the phytoplankton classes to the total PP changed. 48 % of the production was attributed to picophytoplankton, 23 % to nanophytoplankton and 29 % to microphytoplankton. Generally picophytoplankton dominated the PP in the NATL except at 11°N where microphytoplankton accounted for 70 % of the PP and picophytoplankton only 14 % (***Figure 1***). By contrast, in the South Atlantic Sub-Tropical Gyre (SATL, 10 to 40°S) the average PP was 380 mgC m^{-2} d^{-1} and the contribution by the microphytoplankton and nanophytoplankton was slightly higher and picophytoplankton production was lower. 40 % of the production was attributed to picophytoplankton, 29 % to nanophytoplankton and 32 % to microphytoplankton. Similarly, picophytoplankton dominated the PP except at 32°S where microphytoplankton accounted for 60 % of the PP and picophytoplankton accounted for 20 % (***Figure 1***).

Figure 1. Primary production in different size classes of phytoplankton along the AMT18 cruise track.

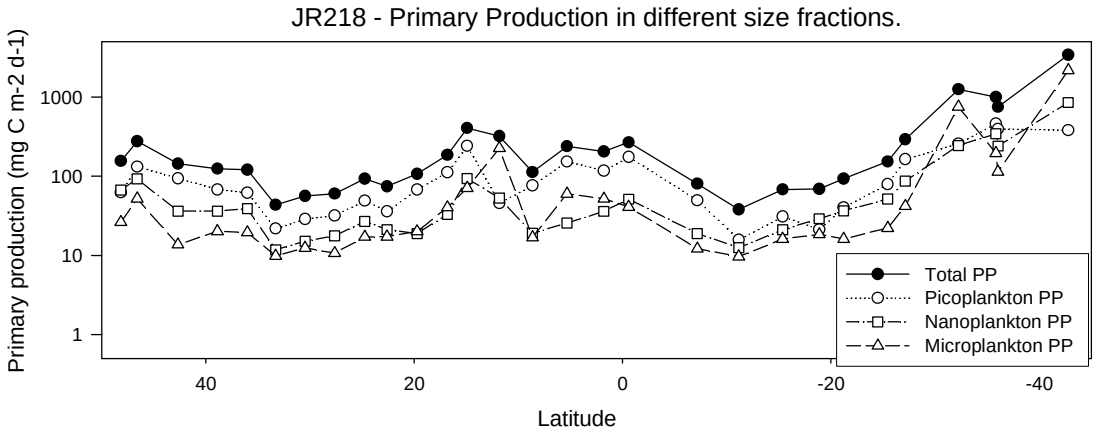
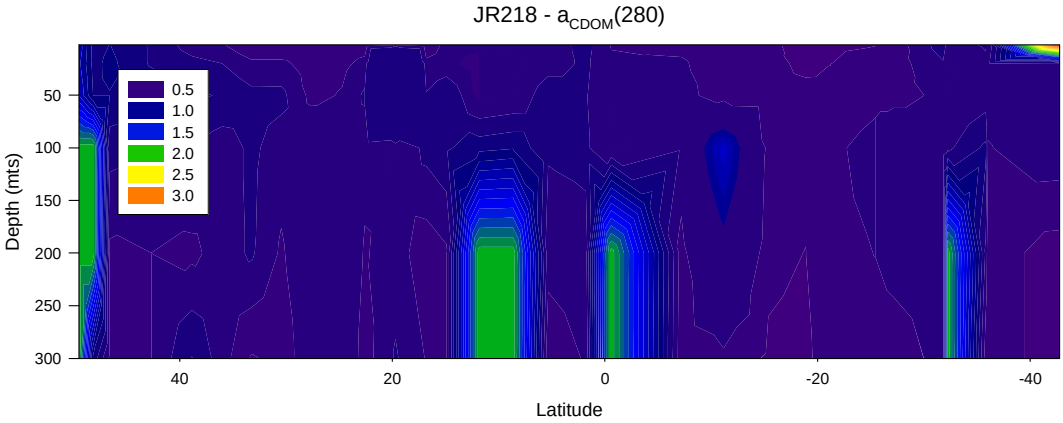


Figure 2. $a_{CDOM}(280)$ along the cruise track.



$a_{CDOM}(280)$ was highest in the surface waters over the Patagonian shelf, at 43°S, where it was >2.0 m^{-1} (***Figure 2***). Similarly, at 48°N over the UK shelf where $a_{CDOM}(280)$ was >1.05 m^{-1} in at 150mts (***Figure 2***). Between 45°N and 15°N $a_{CDOM}(280)$ was similar and between 0.4 and 0.8 m^{-1} from surface to 300 mts. At 11°N, however, and at the equator, $a_{CDOM}(280)$ was >1.05 m^{-1} at and below the deep Chlorophyll-a maximum. From 10° to 36°S again $a_{CDOM}(280)$ was between 0.4 and 0.8 m^{-1} throughout the water column to 300 mts.

References:

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.

CDOM distribution and photochemical production of ammonium

Paul Mann
School of Marine Science & Technology,
Newcastle University. p.j.mann@ncl.ac.uk

Summary
17 Ammonium photoproduction experiments were carried out during the duration of the cruise. Associated optical properties (Fluorescence) and DOM compositional measurements were collected (samples for DOC& TDN). An experiment investigating the effect of CO_2 concentration on photoproduction rates was conducted.

Methods

Photomineralisation experiments 20-25 L of water were collected into pre-acid clean glass carbuoys from the pre-dawn CTD, approximately every other morning. Sample collection depths were varied to provide results from surface (~ 2m depth due to niskin deployment) and base of the mixed layer samples for each province visited. In addition, 2 deep CTD casts were carried out collecting water from 3000m in the central Northern (NATL) and Southern Gyre (SATL) provinces to investigate rates of photochemical degradation and ammonium release in deep CDOM substrates. A list of sample locations and depths can be seen below (Table 1). A single experiment was also carried out with samples exposed to either oxygenation (bubble air) or carbonation (CO_2 bubbled) in order to investigate the effects of increased carbon dioxide on degradation patterns and ammonium release rates (Table 1. red).

After samples were collected (minimising exposure to light), they were immediately transferred to the JCR cold room (5^oC ±1.5 for duration of cruise) and gravity filtered in succession through 0.2/ 0.2 and 0.1/ 0.1µm AcroPak Capsules with Supor Membrane into additional pre-cleaned glass carbuoys. Analysis of filtrate before and after irradiation experiments confirmed this procedure minimised all evidence of microbial communities (pers. Comm. Ross Holland, NOC). Acid/ MQ pre-cleaned quartz and borosilicate irrdiation flasks were then gravity filled and placed into a treatment as required. Duplicate tubes were used as minimum replication (during experiments investigating UV and Vis light effects). Triplicate tubes were used in all experiments when only UV effects were studied (see Table 1 for treatments and irradiation times). Experiments were carried out so as to ensure that at least one no UV experiments (visible light only) were carried out in each province.

Irradiation experiment no.	Position		CTD cast no.	Depth of water used (m)	Treatment	Max irradiation duration (hr)
	Lat.	Long.				
I	49.28.94N	9.50.85E	2	10	Visible	5
II	49.08.954N	14.39.149E	5	6	Visible	6
III	42.40.37N	22.11.625E	11	12	Full	25
IV	36.00.69N	27.44.24E	15	55	Full	25
V	30.28.34N	33.57.06E	21	40	Full	25
VI	24.44.65N	40.05.30E	29	3000	Full	24
VII	16.48.63N	36.12.403E	37	2	Visible	24
VIII	11.49.25N	32.49.45E	44	15	Visible	24
IX	5.20.383N	28.31.275E	50	46	Visible	24
X	0.35.034N	24.59.756E	58	24	Visible	25
XI	14.59.60S	24.59.66W	68	2	Visible	24
XII	22.47.12S	25.00.54W	78	40	Visible	24
XIII	26.33.43S	24.59.87W	84	3000	Full	24
XIV	33.46.09S	32.00.18W	90	54	Full	24
XV	37.58.074S	37.24.763W	96	29	Visible	24
XVI	43.13.599S	44.36.807W	100	2	Full	24
CO2	8.49.52S	24.59.716W	nr. 63	underway (4-6m)	Full	24

Table 1. Details of sample location, depth, treatment and irradiation times for each experiment. Full represents only full spectrum light experiments. Visible indicates both full spectrum and no UV treatments were measured.

Artificial irradiations were carried out using specifically designed light banks (Figure 1, a) containing visible and UV lamps to ensure a constant measured light source for each irradiation (Figure ?, b) (Light banks courtesy of G. Tilstone PML). The light banks were kept in the JCR cold room to minimise room temperature fluctuations and flow through surface water (non-toxic supply) in each light bank ensured each experiment was ran at local surface seawater temperature.

Ammonium concentrations were measured by Paul Mann and Malcolm Woodward using a nanomolar instrument developed by Woodward (PML). This allowed very low ammonium concentration changes to be measured accurately and proved highly successful. ***In-situ*** ammonium and inorganic nutrient concentrations were also measured to allow the observed rates to be placed in context and to assess their environmental importance.

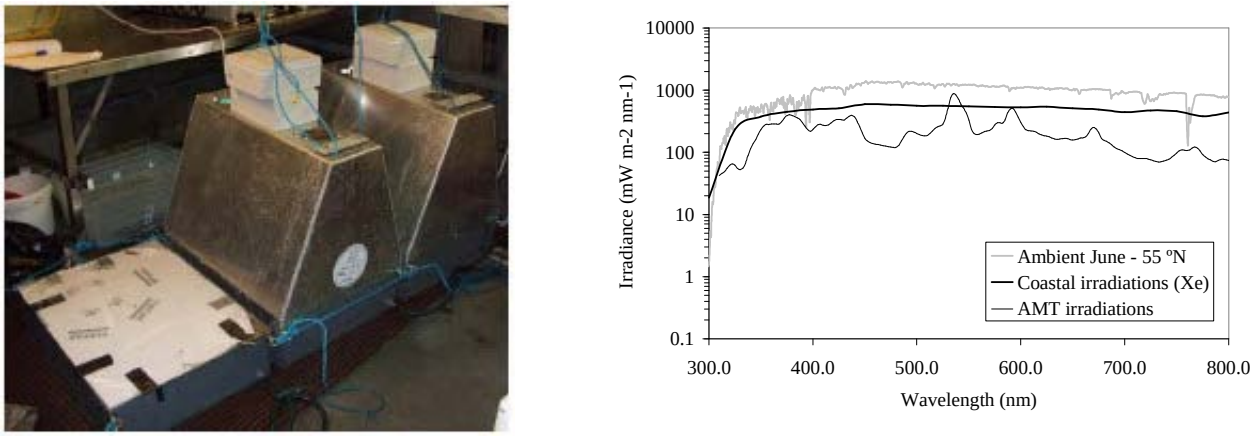


Figure 1. a) Photograph of light banks tied onto floor of JCR cold room. Left bank covered with black plastic to cut out light (dark control). Middle and right, with light hoods in place. b) Irradiance measurements for light banks (lowest dark line), in comparison to ambient summer midday light Newcastle (upper pale grey) and Newcastle solar simulator (middle black) (Courtesy of V. Kitidis & G. Tilstone (PML).

Fluorescence measurements. Concurrent measurements of CDOM fluorescence were taken using a LS50B spectrofluorometer. Seawater samples were collected and filtered in conjunction with CDOM absorption samples (see G.Tilstone AMT cruise report). In brief, samples from 4-8 depths were filtered through 0.2 µm Anodisc filters into acid cleaned glassware. Excitation-emission matrices were measured (???-nm excitation, ??? emission, 5-10nm bandwidth) to allow individual wavelength pairs to be extracted as required (e.g. 'classic' humic regions 320nm ex, 420nm em) and the possibility of extracting independent component fluorophores explored (using Parallel factor analysis - PARAFAC). This will in turn provide information regarding CDOM substrate composition ultimately potentially leading to the development of photochemical degradation proxies. A list of EEM measurements is contained below (Table 2).

Dissolved Organic Carbon (DOC) and Total dissolved N (TDN). Samples were collected for later analysis of DOC and TDN. Samples were collected directly from the CTD niskin through clean tubing and in-line pre-combusted (450^{o}C >4hrs) GF/F filter into pre-combusted glass vials capped with Teflon septa. DOC and TDN samples were collected for the irradiations experiment waters (see Table 1). Additional DOC/ TDN samples were collected from some CTD casts but it is unsure at the moment if these will be analysed due to measurement costs.

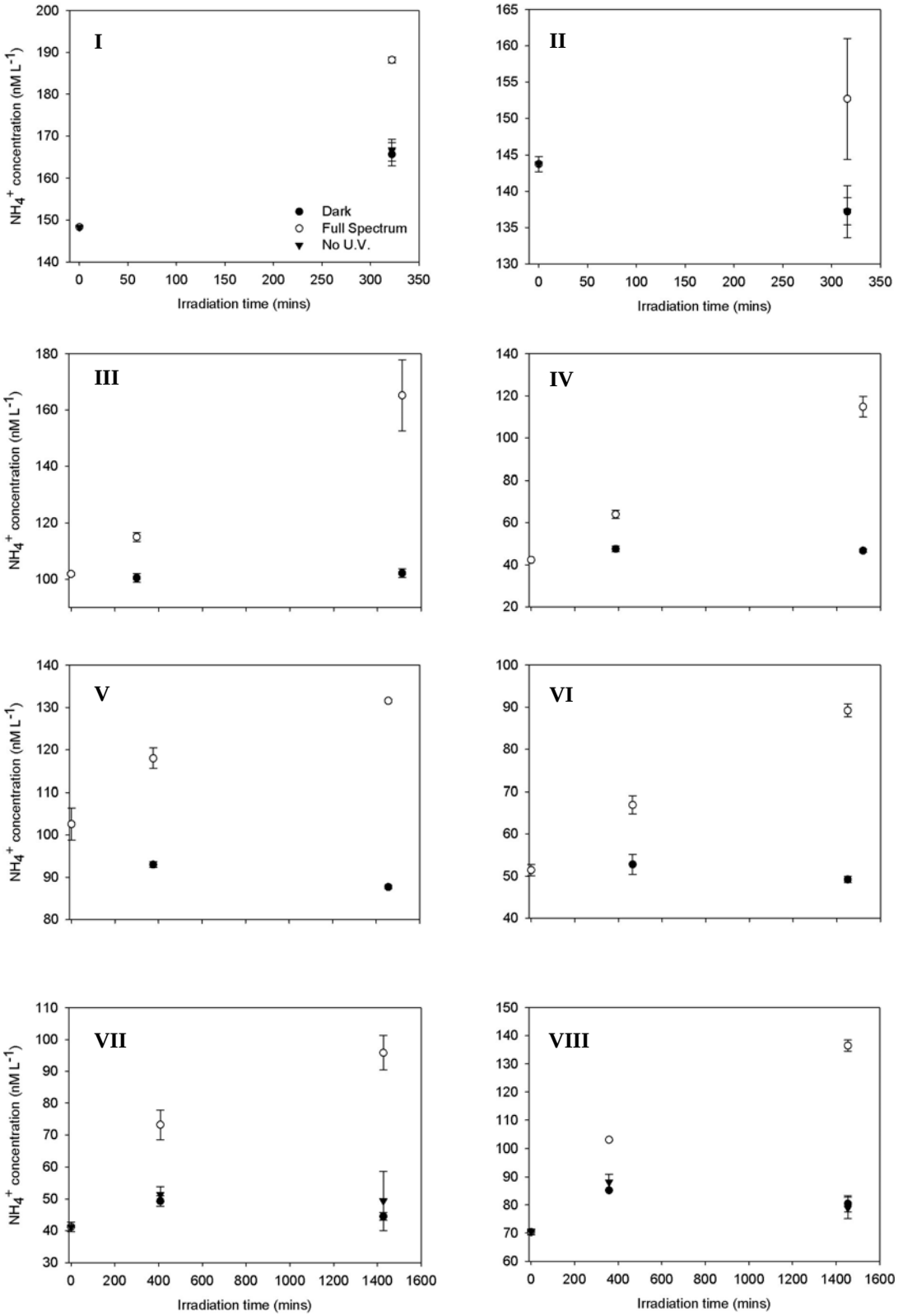


Figure 3. Experiments I-VIII irradiation results. Open circles – full spectrum exposed, black circles – dark controls & black triangles – visible light only. Error bars represent one s.d. All experiments clearly showed ammonium photoproduction.

Date	CTD Station no.	Depths measured
21/10/08	47	2 38 50 98
22/10/08	50	2 46 79 300
23/10/08	55	2 46 70 300
24/10/08	58	2 24 58 120
26/10/08	62	2 60 105 159 300
27/10/08	65	2 45 130 300
28/10/08	69 71	2 58 145 300 530 1000 3000 4530
29/10/08	74	2 125
30/10/08	78	2 40 140 300
31/10/08	82 84	2 31 128 300 800 1300 200
01/11/08	84 86	3000 4571 2 47 110 300
02/11/08	88	2 61 90 300
03/11/08	90	2 30 55 106
04/11/08	93	2 37 98 300
05/11/08	96	2 29 76 200
07/11/08	100	2 26 80 300

Table 2. EEMs collected during cruise. EEMs were also collected earlier along the cruise track but may be poor quality (in comparison to above samples) due to faster scan speeds and different slit width configurations.

Summary

The initial cruise results are very promising and clearly indicate a significant role for ammonium photoproduction processes in the Atlantic within all regions studied. Work will continue to calculate integrated column photoproduction rates harnessing the optical rig UV and visible light measurements in conjunction with the production rates measured here. This will allow regional estimates of the relative contribution of ammonium photoproduction on nutrient limitation, which will be compared to other sources such as atmospheric deposition and fixation. Further processing of the optical measurements will continue to investigate if a link between DOM composition and rates of release can be identified. DOC and TDN analyses will be measured assuming funds can be found.

NUTRIENTS Cruise Report
RRS JAMES CLARK ROSS, JR218

MALCOLM WOODWARD and CAROLYN HARRIS
PLYMOUTH MARINE LABORATORY, UK

OBJECTIVES:
To investigate the spatial and temporal variations of the micromolar nutrient species Nitrate, Nitrite, Silicate, Ammonium and Phosphate during the research cruise along the Atlantic Meridional Transect cruise track, sailing from the UK (Immingham) through the North Atlantic gyre, south to the equator, through the southern gyre before turning south west to end the cruise in the Falkland Islands.

We also carried out in conjunction with Paul Mann (Woodward's PhD student), Gavin Tilstone and Vasilis Kitidis, a series of photo-production experiments using in-lab light incubators (see Tilstone cruise rep) to study various aspects of ammonium photo-production and related analyses like CDOM, DOC etc. These were carried out over a 24 hour time course and the ammonium samples were analysed by a nanomolar ammonium analyser that was deployed on the cruise.

SAMPLING and ANALYTICAL METHODOLOGY:
The micro-molar analyser was a 5 channel (nitrate, nitrite, phosphate, silicate, ammonium) Bran and Luebbe AAIII segmented flow, colorimetric, autoanalyser, and classical proven analytical techniques were used.

The nanomolar ammonium analyser was a technique based on the gas diffusion of the ammonia across a Teflon membrane and then its reaction with a fluorescent reagent and the subsequent detection by a hitachi fluorimeter.

Water samples were taken from a 24 x 20 litre stainless steel CTD/Rosette system (SeaBird).These CTD bottles were sub sampled into acid clean 60 mls HDPE (nalgene) sample bottles and analysis for the nutrient samples was in most cases complete within 3-4 hours of sampling. Clean handling techniques were employed to avoid any contamination of the samples, particularly for the ammonium samples. No samples were frozen or stored in any way.

CTD SAMPLES ANALYSED

Date	CTD	Time in	CTD Bottles analysed
06/10/08	002	0430	23,21,18,13,12,11,10,9,6,5,4,2,1
06/10/08	004	1245	23,20,18,13,12,11,10,9,6,5,4,2,1
07/10/08	005	0425	23,21,18,13,12,9,11,10,4,6,5,2,1
07/10/08	007	1250	23,20,18,13,12,11,10,6,5,4,2,1
08/10/08	008	0425	23,21,18,14,13,12,11,10,7,6,4,3,2,1
08/10/08	010	1245	23,20,18,13,12,11,10,6,5,4,2,1
09/10/08	011	0420	23,21,18,14,13,12,11,10,7,6,4,3,2,1
10/10/08	013	0420	23,21,18,14,12,11,7,13,4,10,3,6,2,1
11/10/08	015	0526	23,22,19,17,15,10,12,9,13,6,8,3,4,2,1
11/10/08	017	1242	23,20,18,13,12,11,10,9,7,6,3,2,1
12/10/08	018	0325	23,22,19,16,15,12,10,8,7,6,5,3,2,1
12/10/08	020	1340	23,20,18,13,12,11,10,9,7,6,3,2,1
13/10/08	021	0521	22,21,20,18,14,11,10,9,8,6,5,4,2,1
13/10/08	023	1322	23,24,18,13,12,11,6,10,9,7,3,2,1
14/10/08	024	0524	22,21,20,17,14,11,10,9,8,6,5,3,2,1
14/10/08	026	1333	23,20,18,13,12,11,10,9,7,6,3,2,1
15/10/08	027	0522	22,21,20,17,14,11,10,9,8,6,5,3,2,1
15/10/08	029	0845	24,23,22,21,20,19,18,17,16,15,14,13,12,11,5,3,2
16/10/08	031	0524	22,21,20,17,14,11,10,9,7,6,5,3,2,1
16/10/08	033	1330	23,20,18,16,13,12,11,7,6,10,3,2,1

17/10/08	034	0523	22,21,20,17,14,11,10,9,7,6,5,3,2,1
17/10/08	036	1333	23,20,18,14,13,12,11,10,7,6,3,2,1
18/10/08	037	0520	22,21,20,17,14,11,10,9,8,7,5,3,2,1
18/10/08	039	0842	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,6,5, 4,3,2
19/10/08	041	0521	22,21,20,17,15,14,10,9,11,7,6,5,3,2,1
19/10/08	043	1338	23,20,18,14,13,12,11,10,9,6,3,2,1
20/10/08	044	0521	21,20,17,12,14,13,9,8,6,4,3,2,1
20/10/08	046	1336	23,20,18,14,11,13,10,12,9,6,3,2,1
21/10/08	047	0518	22,21,20,17,14,11,10,9,7,6,4,3,2,1
21/10/08	049	1335	23,20,18,14,11,10,13,12,9,6,3,2,1
22/10/08	050	0522	22,21,20,17,14,11,10,9,8,7,5,3,2,1
22/10/08	054	1340	23,20,18,14,11,10,13,9,12,6,3,2,1
23/10/08	055	0518	22,21,20,17,14,11,10,9,8,6,5,3,2,1
23/10/08	057	1337	23,20,18,14,11,10,13,12,9,6,3,12,1
24/10/08	058	0515	22,21,20,17,10,14,11,9,8,6,5,3,2,1
24/10/08	060	1310	23,20,18,14,13,11,12,10,6,9,3,2,1
25/10/08	061	1450	23,20,18,14,13,12,11,89,10,6,3,2,1
26/10/08	062	0518	22,21,20,71,14,11,15,10,9,8,6,5,3,2,1
26/10/08	064	1331	23,20,18,14,13,12,11,10,9,6,3,2,1
27/10/08	065	0517	22,21,20,17,14,11,9,8,7,6,5,3,2,1
27/10/08	067	1335	23,20,18,14,13,12,9,11,10,6,3,2,1
28/10/08	069	0518	22,21,20,17,14,11,10,8,7,15,5,3,2,1
28/10/08	071	0720	24,23,21,20,19,18,17,16,15,14,13,12,11,10,7,6,5,3,2
29/10/08	074	0516	22,21,20,71,14,11,9,8,7,6,5,3,2,1
29/10/08	076	1345	23,20,18,14,13,12,11,8,7,6,3,2,1
30/10/08	078	0529	22,21,20,17,14,11,9,8,7,6,5,3,2,1
30/10/08	080	1340	23,20,18,14, 13,12,11,8,7,6,3,2,1
31/10/08	082	0513	22,21,20,17,14,11,10,9,8,6,5,3,2,1
31/10/08	084	0832	2,3,5,7,12,16,18,19
31/10/08	085	1400	23,20,18,14,13,12,8,7,11,6,3,1
01/11/08	086	0517	22,21,20,17,14,11,10,9,7,6,5,3,2,1
02/11/08	088	1450	23,20,18,14,13,12,8,7,6,11,3,2,1
03/11/08	090	0652	22,21,19,17,14,10,9,11,8,7,5,3,2,1
03/11/08	092	1446	23,20,18,14,13,12,11,8,7,6,3,2,1
04/11/08	093	0517	22,.21,20,17,41,11,9,8,7,5,4,3,2,1
04/11/08	095	1436	23,20,18,14,13,12,11,8,7,3,6,2,1
05/11/08	096	0520	22,21,19,17,13,11,10,8,7,6,4,3,2,1
05/11/08	098	1428	23,20,18,14,13,12,9,8,3,7,6,2,1
06/11/08	099	1430	23,20,18,8,14,13,7,12,6,11,23,2,1
07/11/08	100	0524	22,19,18,14,11,9,8,6,5,4,3,2,1
07/11/08	102	1420	23,20,18,14,13,8,12,7,6,11,3,2,1

Ammonium Photoproduction Experiments start dates:

Ammoniafication Expt 1 – 6th October
Ammoniafication Expt 2 – 7th October
Ammoniafication Expt 3 – 9th October
Ammoniafication Expt 4 – 11th October
Ammoniafication Expt 5 – 13th October
Ammoniafication Expt 6 – 16th October
Ammoniafication Expt 7 – 18th October
Ammoniafication Expt 8 – 20th October
Ammoniafication Expt 9 – 22nd October
Ammoniafication Expt 10 – 24th October

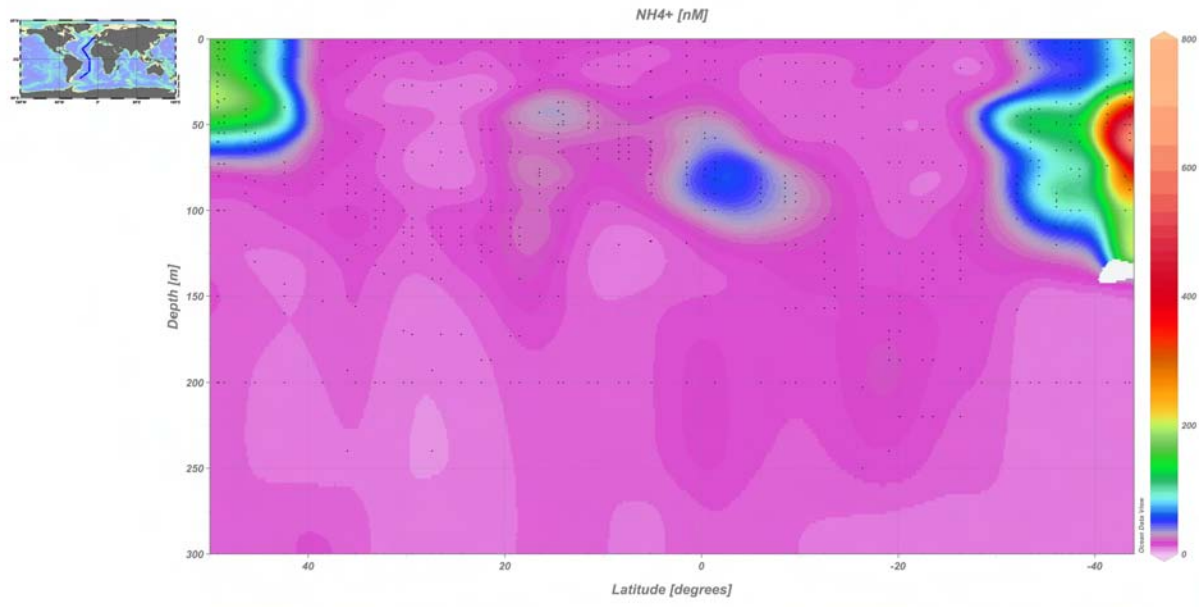
Ammoniafication Expt 11 – 27th October
Ammoniafication Expt 12 – 28th October
Ammoniafication Expt 13 – 30th October
Ammoniafication Expt 14 – 1st November
Ammoniafication Expt 15 – 3rd November
Ammoniafication Expt 16 – 5th November
Ammoniafication Expt 17 – 7th November

For details of the entire Photo-production experiments and set up etc, see cruise report of Paul Mann and Gavin Tilstone.

CRUISE RESULTS and SUMMARY

The 5-channel autoanalyser worked very well throughout the cruise, but no data handling or work-up was carried out on the cruise. The nanomolar ammonium analysis was all completed satisfactorily and a good set of data was produced which was worked up in real time as we progressed south, giving both an Atlantic transect for the ammonium water column concentrations and also the results were important for Paul Mann's results and interpretation with the photo-production experiments. Results from those experiments can be seen in Paul's report.

Results here shown for the ammonium Atlantic depth profile:



Thanks: To the JCR her officers, crew for making it all possible. Thanks to all those who helped on occasions with sampling and washing bottles. Special thanks to all the other cruise scientists for making this cruise a pleasure to be a part of, a great team effort.

Malcolm Woodward and Carolyn Harris. 8th November 2008

Coccolithophore biogeography

Martine Couapel and Jeremy R. Young
Palaeontology Department, The Natural History Museum, London SW7 5BD

Background

Coccolithophores are a prominent component of the open ocean phytoplankton. They typically dominate the eukaryotic phytoplankton within the oceanic gyres, but occur throughout the Atlantic. In addition to their role as primary producers they are the most important single contributors to pelagic carbonate sedimentation. Consequently they are of great interest to geologists and biogeochemists as well as marine biologists and have been the subject of extensive multidisciplinary research (e.g. Thierstein &Young 2004, de Vargas et al. 2007). This combined with their relatively well-established taxonomy (Young et al. 2003) makes them an ideal group for monitoring the response of phytoplankton to global change.

The AMT project provides an uniquely suitable platform for conducting this type of research since: (1) The sampling through the Atlantic is ideal for mapping out the large scale biogeography of coccolithophores; (2) the chemical and physical oceanographic analyses undertaken during AMT cruises provide the full suite of environmental data needed to interpret assemblage data; (3) lower resolution studies of coccolithophore assemblages have been undertaken by different research groups throughout the history of AMT research; (4) complimentary analyses of other aspects of coccolithophore biology are being routinely undertaken by the research team of Barney Balch;.(5) the long term nature of the AMT project allows for repeat sampling in the future.

Objectives and collaboration

1. To carry out high resolution analysis of nannofossil assemblages from AMT18, including particularly detailed sampling through the water column. This will be used to (1) Refine understanding of coccolithophore biogeography through the Atlantic; (2) Analyse patchiness and predictability of this representative group of phytoplankton; (3) Provide reliable autecological data for most coccolithophore species.
2. In collaboration with Alex Poulton (NOC, Southampton) to synthesise data from past AMT cruises, and other published studies, to analyse variability and predictability of coccolithophores through the Atlantic.
3. Collect medium resolution set of samples using the COD-FISH protocol to allow DNA probe studies of distribution of specific taxonomic groups, and when specific or generic level probes are available to identify life cycle phases. To be carried out in collaboration with research group of Colomban de Vargas (SB Roscoff).
4. To collect a set of environmental DNA samples from across the AMT transect for clone library study of haptophyte diversity, to be carried out in collaboration with research group of Colomban de Vargas (SB Roscoff), and with David Bass (NHM).

Sampling for coccolithophore assemblage analysis

Regular casts; Filter samples for coccolithophore assemblage analysis were collected from both the pre-dawn (second cast) and solar noon stations. Typically samples of ca 5l were taken from 9 or 10 depths This usually included six light level determined depths (97%, 55%, 33%, 14%, 1% and 0.1%) plus sampling of the DCM as determined from the fluorometer on the downward cast and fixed depth samples from 200 and 300m) at each pre-dawn cast and 13 depths from each solar noon station. This intense sampling was designed to produce a set of samples fully covering the mixed layer deep chlorophyll maximum and deep photic populations (fig. 1d). For almost all water samples two filter preparations were made, one for light microscope (LM) and one for scanning electron microscope (SEM) analyses. Usually a 13 mm cellulose 1.2 µm porosity (LM) and a 47 mm 1µm porosity anodisc (SEM) filters were use for the pre-dawn cast, and 47 mm cellulose

(LM) and polycarbonate (SEM) 1µm porosity filters for the solar noon cast. Filters were oven dried directly after filtration and microscope slides then prepared from a portion of the LM filters. The remaining LM filter portion and SEM filters were archived in millipore petrislides for subsequent study. Preliminary analyses of about half the LM samples were carried out on ship using cross-polarised light microscopy, to provide an overview of the abundance and dominant components of the assemblages. Selected specimens were imaged during this work.

Evening casts: three evening casts were carried out in the South Atlantic (stations 66, 71 and 74). Two samples from the surface and 20 m depth were taken from each of these stations.

NHM cast: A prominent result of our light microscopic reconnaissance work was that the there was a more complex vertical succession of coccolithophore communities than has generally been appreciated. To obtain extended sampling of this diversity we were able to undertake a special cast toward the end of the cruise. This additional cast allowed a high-resolution (every 12 m) investigation of coccolithophore distribution within the top 276 m of the water column, at the southern edge of the South Atlantic gyre (CTD station 89, 32°S).

Deep casts: Four deep casts were undertaken during the cruise sampling through the water column to near the ocean bottom (4190 to 5150m), primarily to study water mass properties. We collected 15 to 21 samples from each of these stations. Coccolithophores rarely occur below 200m but sinking coccoliths are present through the water column and these samples will be used to study coccolith assemblage transformation during sedimneation to the sea floor. Study of the samples will be carried out in collaboration with Luc Beaufort (CEREGE, France) using the SYRACO automated count system.

Summary: In total 800 water samples were collected representing over 3200 l) and more than 1600 filter preparations, preliminary analyses were carried out on ship on 357 samples and 1200 LM images taken.

Sampling for COD-FISH analysis

COD-FISH is a modification of Fluorescence In-Situ Hybridisation (FISH) method using non-acidic buffers (Frada et al. 2006). It allows cross-polarised light identification of coccolithophores to be combined with fluorescent labelling of cells by DNA probes. Study of these filters will be conducted in collaboration with the research team of Colomban de Vargas (Station Biologique de Roscoff) who has developed a range of probes for different coccolithophore groups.

COD-FISH samples were usually collected at 6 depths from pre-dawn cast 2. Altogether 90 samples were recover from 20 different stations along the transect, and 11 from the NHM cast representing over 85 l of seawater filtered (fig. 1g). Duplicate samples were taken at two stations to test result reproducibility. Water samples were pre-filtered through a 53µm mesh then a precise volume of seawater (between 0.5 to 1 l) was fixed using 10 or 1% PFA according to the oceanic region, and incubated in the fridge at 4°C, usually for 1h. The preparation was then gently mixed and filtered through a 25 mm 0.22 µm anodisc membrane filter using a low vacuum pressure. At the end of the filtration, the filter was rinsed in a series of increasing purity ethanol baths, and then fixed with gelatine. The filter was dried at room temperature, then stored in a petrislide dish, and frozen at -20°C.

Environmental DNA samples

Molecular genetic studies of microplankton have traditionally been limited to species available in culture, which for oceanic groups such as coccolithophores is a very limited sampling of total diversity. Increasingly the alternative approach of analysing DNA diversity from bulk samples is being used to circumvent this bottleneck. We have been collaborating with the research team of Colomban de Vargas (Station Biologique de Roscoff) in application of this methodology to study of coccolithophore diversity through parallel study of morphological and molecular diversity of selected samples (Hui et al. in prep). Some of the collected bulk DNA samples will also be used by David Bass (NHM, Zoology Dept.) for a multi-library DNA environmental PCR survey of Cercozoa.

Bulk DNA samples were usually collected from the surface and the DCM at pre-dawn cast 2. Altogether 82 samples were recover from 32 regular stations along the transect, and 11 from the NHM cast, with in total 940 l of seawater concentrated (fig. 1h). At one station a pair of duplicate samples was collected, to test result reproducibility. Seawater was pre-filtered through a 53 µm mesh during recovery from Niskin bottles into a 15l plastic carboy. A sterile vented filter unit Sterivex^{TM}-GV 0.22µm was then connected with silicone tubing to a peristaltic pump, using gloves and put into the carboy. This arrangement with the filtration unit immersed in the sample was used to eliminate potential leaks at connections. The filtering was continued for 20 h or until 10 l had been filtered. The filter unit was then removed from the water but kept connected to the pump for 1 hour to dry out. Subsequently, 2.5 ml of buffer solution was injected into the filter unit with a micropipette. Finally the filter unit was sealed using a special lid and a micropipette burnt closed, and frozen at -20°C.

Preliminary results

The bulk of our analyses will be undertaken over the next eighteen months, together with synthesis of data from previous AMT coccolithophore studies. Some preliminary results are, however, available from our shipboard LM analyses. In figure 1 we summarise the LM count data in terms of total abundance of coccolithophores (1e) and dominant species in the assemblage (1f). Most of these assemblage dominating species are illustrated in figure 2. This is preliminary data based in some cases on counts of low numbers of specimens. Nonetheless a general pattern of remarkably coherent data is evident, as was also noted on ship. There is a clear contrast between temperate high abundance low diversity assemblages at the north and south ends of the transect and topical-subtropical assemblages through the rest of the transect at the northern end of the transect the transition occurred abruptly at about 46N at the southern end it occurred at about 31S, although gales disrupted sampling. Through the main part of the cruise both coccolithophore abundances and dominant species show rather complex depth related patterns clearly related to depth of the deep chlorophyll maximum. The low number of assemblage-dominating species reflects the significant predictability of coccolithophore assemblages supporting the hypothesis that they can be used as an indicator group to determine if significant changes in phytoplankton have occurred in the historical past and monitor future effects of climate change.

Public outreach

During the course of the cruise we produced a internet blog diary for the NHM website, to give non-scientists an idea of modern scientific collection work. This is available on the NHM website at http://www.nhm.ac.uk/nature-online/science-of-natural-history/expeditions-collecting/coccoliths-blog/ (short address http://tinyurl.com/coccoblog). We will also be using the cruise results and experience as the basis for public science talks in the NHM.

Acknowledgements

We are very grateful to the captain and crew of the ***James Clark Ross*** for facilitating our research and making participation in the cruise an uniquely rewarding experience. Equally importantly our scientific colleagues and chief scientist Malcolm Woodward generously assisted and supported our work and our constant request for water. In particular we should thank Glenn Tarran, Martin Ostrowski, Galvin Tilstone and Mike Zubkhov for lending us equipment and supplies, and Clive Jones for his 'on land' support. We are also very grateful to Andy Rees and Alex Poulton for encouraging and facilitating our participation in the AMT programme. Our research was supported financially by the EU via the COMBINE Marie Curie fellowship programme and by the French ANR BOOM project.

References

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Hui, L., Young, J. R., Couapel, M., Probert, I. & de Vargas, C. in prep. A morpho-genetic approach to studying phytoplankton diversity: The case of coccolithophore. ***Marine Ecology Progress Series***.

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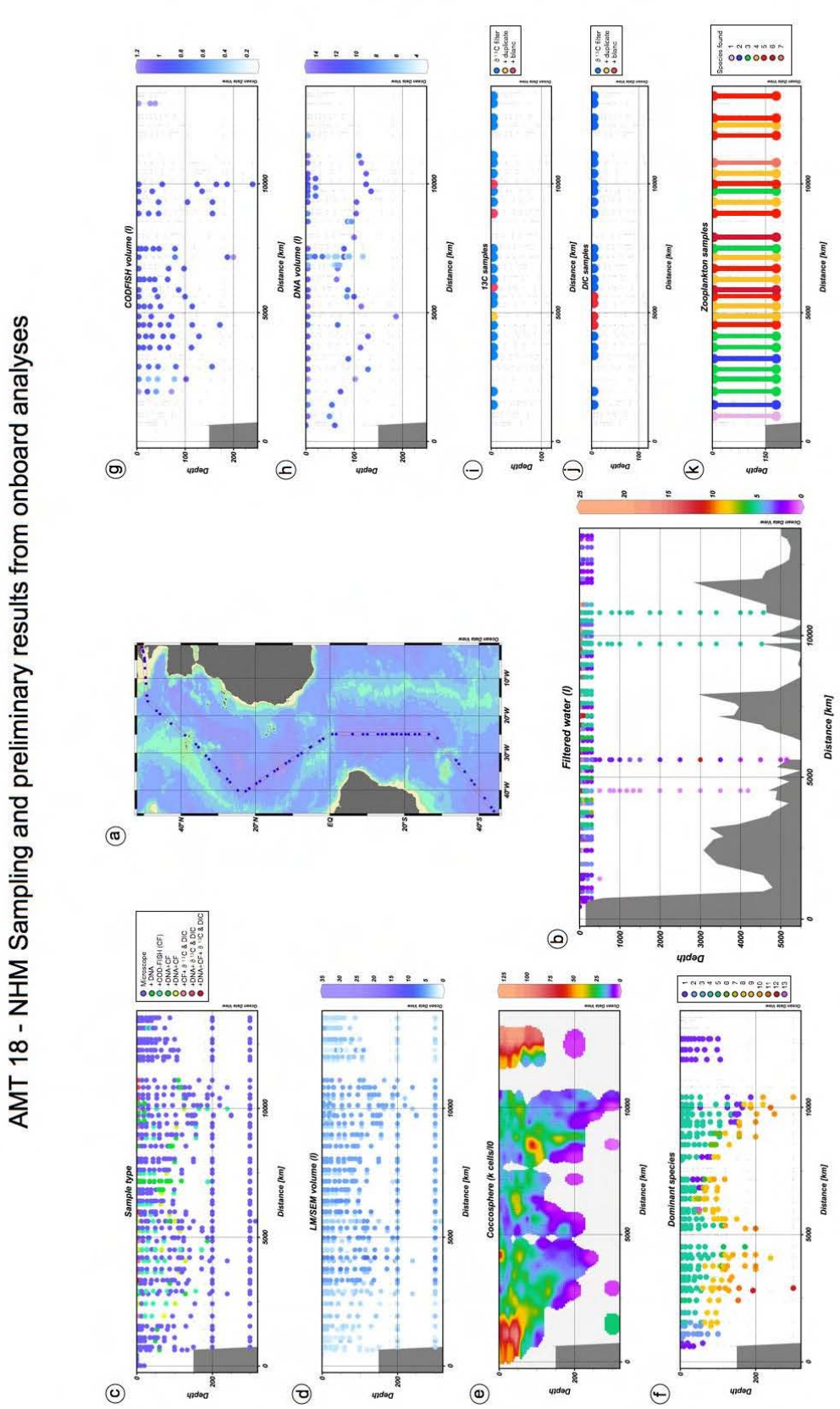
Figure 1 (next page) Summary of sampling

NB Fig. 1f Dominant species data

To allow a rapid summary of the coccolithophore assemblage count data the samples were categorised according to the most abundant species; which together formed ca. 50% of the assemblage.

This resulted in 13 categories as plotted on figure 1f.

1 ***Emiliania huxleyi***
2 ***E. huxleyi +*** other
3 ***Gephyrocapsa muellerae***
4 ***G. muellerae +Florisphaera profunda***
5 ***Umbellosphaera spp. + G muellerae***
6 Umbellosphaera spp. + other
7 ***Algirosphaera robusta + F. profunda***
8 ***Oolithotus antillarum +Helicosphaera spp.***
9 ***F. profunda + Gephyrocapsa***
10 ***F. profunda***
11 ***F profunda + Gladiolithus flabellatus***
12 G. flabellatus + F. profunda
13 G. flabellatus


AMT 18 - NHM Sampling and preliminary results from onboard analyses
Filtered water (l)
Depth
Distance [km]
Ocean Data View
COD/FISH volume (l)
DNA volume (l)
13C samples
DIC samples
Zooplankton samples
Sample type
LM/SEM volume (l)
Coccosphere (k cells/l)
Dominant species

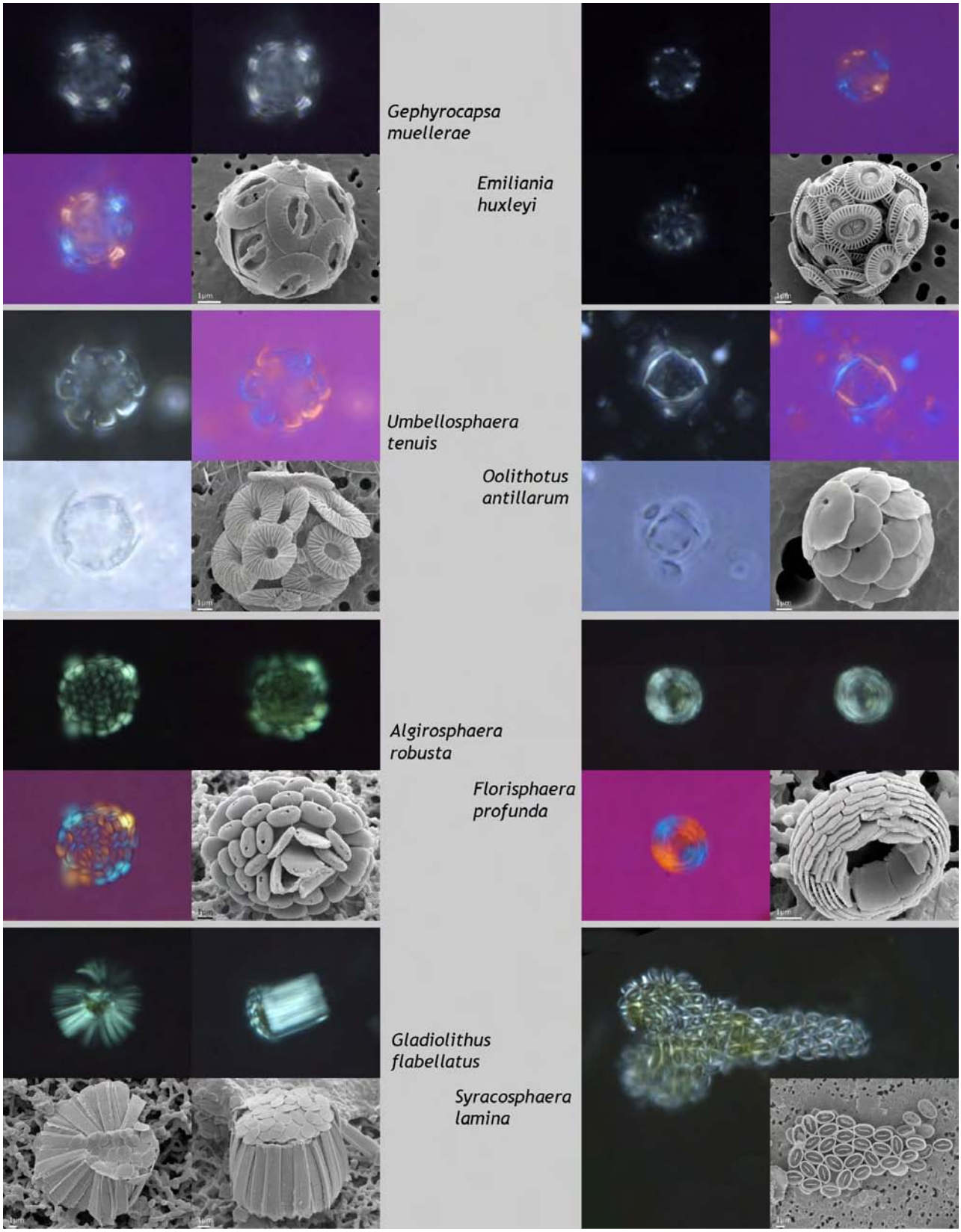


Fig 2. Light and electron micrographs illustrating eight species which dominate assemblages in one or more examined samples. NB Not all images are from AMT18 samples.

∂^{13}C and Dissolved Inorganic Carbon (DIC) sampling

Martine Couapel
Palaeontology Department, The Natural History Museum, London SW7 5BD

Objectives

The objective was to examine variation in isotopic fractionation of carbon in surface water between Particulate Organic Carbon (POC) and Dissolved Inorganic Carbon (DIC) across the broad latitudinal range afforded by the AMT transect. Pairs of sampled were collected to enable this; filtered bulk organic samples for analysis of ∂^{13}C in POC and sea water samples for analysis of ∂^{13}C in DIC.

Methods

A set of 31 ∂^{13}C and DIC samples was collected (fig. 1i,j), along with 'blank' samples to correct any sampling artefact and two duplicate samples to test the result reproducibility. Between 5 and 15 l of near-surface water from the ship's non-toxic seawater supply was collected in a carboy during the pre-dawn station to recover 5-6 mg of algal wet biomass to measure total POC ∂^{13}C. The carboy was filled to the top to avoid extra chemical exchange before subsequent DIC sampling and filtration, and gloves were wore during the whole process. The DIC samples were collected using a 25 ml disposable syringe and poured through a 0.2 μm disposable filter into a pre-poisoned vial. The vials were then sealed with a blowtorch, labelled, covered with aluminium foil and stored at 4°C in the fridge.

The ∂^{13}C samples were filtered under vacuum through pre-combusted 47 mm, 0.7 μm GF/F membranes using a pre-combusted glass filtration unit. The filters, filtration unit and the carboy were systematically rinsed with HCL and milliQ water between each sample to remove any inorganic carbon. At the end of the filtration, the filters were rinsed with milliQ water to remove Cl^- ions. They were then put onto a piece of pre-combusted aluminium foil, and dried for at least 12 hours at 60°C. The foil was closed, labelled and the sample store at 4°C in the fridge. The blank samples were just filters rinsed with HCL, then milliQ water and dried before storage.

Collaborators

The collecting was undertaken in collaboration with Ros Rickaby and Jodi Young from Oxford University who are currently analysing the samples.

References

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Bentaleb, I., Fontugne, M., Descolas-Gros, C., Girardin, C., Mariotti, A., Pierre, C., Brunet, C.,, Poisson, A., 1998. Carbon isotopic frationation by plankton in the Southern Indian Ocean: relationship between ∂^{13}C of particulate organic carbon and dissolved carbon dioxide. ***Journal of Marine System* 17**, 39-58.

Pteropod molecular biology

Jeremy R. Young
Palaeontology Department, The Natural History Museum, London SW7 5BD

Background

Planktonic gastropods, pteropods are a widespread component of the zooplankton which are relatively understudied. In the context of ocean acidification interest in them has recently increased dramatically. In addition they are interesting for evolutionary studies since they are the only group of metazoan zooplankton with a significant fossil record. They have been well-studied in terms of descriptive taxonomy and intriguingly these purely morphological studies lead to strong suggestions that many conventionally recognised species are in fact clades of closely related pseudo-cryptic species, a pattern which has been highlighted by molecular genetic studies in many other groups. Molecular studies on the group have been inhibited by the absence of suitably preserved specimens (formaldehyde destroys DNA) so new material was required for such study

Objectives

The objective of the pteropod sampling was to collect a set of fresh pteropod specimens preserved in alcohol to allow a preliminary study of their molecular phylogeny and to obtain data on the degree of genetic variability within the most abundant species.

Collaborators

The collecting was undertaken in collaboration with gatropod taxonomists inthe NHM (Jon Todd, Palaeontology and Ellinor Michel, Zoology) and with Dutch colleagues Katja Peinenberg (U. Amsterdam, specialist on zooplankton microevolution), and Arie Jansssen (retired authority on fossil pteropods).

Methods

Zooplankton samples were collected by Chris Gallienne (PML) using a 200µm mesh bongo net cast to 180m as part of the regular AMT zooplankton work (see separate report). From these samples a sub-sample was provided to JRY each day. This sample was picked kept in a cool room until sampling later in the day. Picking was carried put.under a binocular microscope using flexible forceps and all pteropods encountered were transferred into a bath of 99.7% ethanol. Selected specimens were then photographed before transfer into microcentrifuge tubes filled with clean ethanol and storage in the cool room refrigerator. At the end of the cruise the ethanol was changed in all samples and the specimens were stored in the science freezer for return to the UK.

Summary of samples collected

Specimens were picked from 29 samples (fig 1k) and in total about 500, mainly juvenile, pteropods were collected. The assemblages were dominated by ***Limacina*** species, especially ***L. inflata***, but a useful sampling of broader diversity was achieved including specimens ***of Clio, Styliola, Cavolinia, Diacria*** and ***Cuveriana.*** There is a bias in the sample set toward the South Atlantic, reflecting improvements in picking technique through the course of the cruise (Figure 1). Overall the sampling was ideal for our objectives with the large collection of ***Limacina*** being suitable for study of intraspecific variation and the broader sampling suitable for developing a large scale molecular phylogeny. A few representative specimens are shown in Figure 3.

Acknowledgements

Numerous colleagues on ship encouraged this work, but I am uniquely indebted to Chris Gallienne for providing the zooplankton sub-samples.

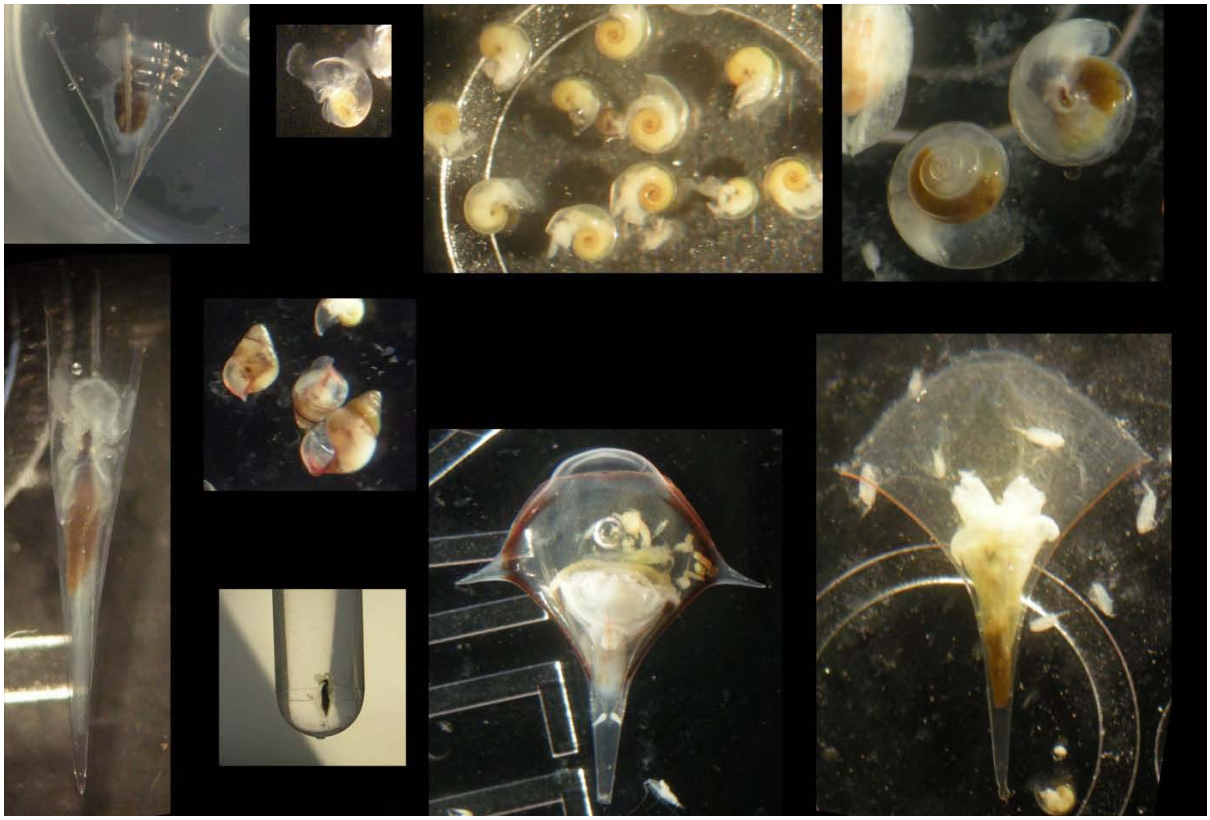

Figure 3. Specimens of pteropods as collected and image on ship.

Factors Affecting Community Structure of Marine Picocyanobacteria

(Ostrowski, Pearman)

1. Determination of the horizontal and vertical distribution of genetically distinct populations of ***Prochlorococcus (Pro), Synechococcus (Syn),*** pico- and nano-eukaryotes (Peuk)***.***
2. Isolation of Syn, Pro and Peuk cultures with the aid of flow-sorting.
3. Metagenomics and transcriptomics of flow-sorted Syn and Peuk populations at selected stations
4. Concentration of biomass samples for elemental composition analysis of flow-sorted ***Syn, Pro*** and ***Peuk*** cells using X-Ray TEM and High Resolution Inductively-Coupled-Plasma Mass Spectrometry (HR ICP-MS)
5. Phage: samples and experiment

1. Distribution of *Pro, Syn* and Peuk

1a. Sampling strategy

Bulk community DNA was collected at the 2nd pre-dawn CTD from 6 light depths (97, 55, 14, 7, 1 and 0.1%) (Table 1). Up to 12 l vol from each depth was pre-filtered through 100 µm mesh and 10.0 µm polycarbonate (PC) filters while the 5.0µm (PC) and 0.45 µm (Supor) fractions were retained and flash frozen (liq. N_2) in 3.0 ml of lysis buffer and stored at -80˚C. Additionally, 500 ml samples from 2 depths were fixed with PFA (0.1%w/v, 1h, 4˚C) and concentrated by gentle vacuum filtration onto 0.2 µm membranes and stirred at -80˚C for analysis by Fluorescence ***in-situ*** Hybridisation (FISH) with lineage-specific probes for ***Syn, Pro*** and Peuk.

1b. Proposed analyses

DNA will be extracted from filters using established techniques and analysed by a variety of methods in the laboratory. Semi-quantitative estimates of the abundance of up to 6 ribotypes of ***Pro***, 16 ribotypes of ***Syn*** and more than 10 plastidic ribotypes for Peuks will be obtained using dotblots with ^{32}P labelled probes. Supporting analyses include construction of clone libraries for 16S ribosomal RNA and internal transcribed spacer (ITS) regions, clone libraries and (t)RFLP analyses of MLSA marker genes (such as ***petB***). Estimates of species/ribotype abundance will complement the flow cytometric analsyses of underway and CTD samples (Tarran/Holland) as well as allow for direct comparison with similar data obtained on AMT-15 (Zwirglmaier et al., 2008) and AMT-13 (Johnson et al., 2006). A total of 32 stations were sampled for a total volume of 1,920 l of seawater filtered.

Table 1. Summary of size-fractionated bulk DNA samples. Samples were concentrated from 5.0 -10.0 l of seawater and pre-filtered through 100 µm mesh and 10.0 µm filters. Concentrated samples were retained on 5.0 and 0.45 µm filters and flash frozen.

cryo-box	cast	CTD	date	lat˚ N	lon˚ W	depths (m)	notes
UWAR1	pre-dawn-2	JR218_003	6-Oct	49˚28.96	9˚50.83	surf, 10, 25, 35, 60, 100	no light depth calibration
UWAR1	pre-dawn-2	JR218_006	7-Oct	49˚8.96	14˚39.15	surf, 6, 12, 21, 49, 73	
UWAR1	pre-dawn-2	JR218_009	8-Oct	46˚35.44	18˚41.80	surf, 7, 13, 23, 54, 81	
UWAR1	pre-dawn-2	JR218_012	9-Oct	42˚40.38	22˚11.70	surf, 12, *22, 40, 95, 143	
UWAR2	pre-dawn-2	JR218_014	10-Oct	38˚52.91	25˚19.46	surf, 13, 24, 43, 102, 154	
UWAR2	pre-dawn-2	JR218_016	11-Oct	36˚0.70	27˚44.24	surf, 16, 55, 74, 129, 193	
UWAR2	pre-dawn-2	JR218_019	12-Oct	33˚17.87	30˚47.82	surf, 11, 37, 50, 88, 132	
UWAR2	pre-dawn-2	JR218_022	13-Oct	30˚28.34	33˚57.07	surf, 14, 48, 65, 113, 120	
UWAR3	pre-dawn-2	JR218_025	14-Oct	27˚37.90	37˚1.83	surf, 19!, 55, 74, 129, 193	!not enough water for dot blot filter (I.e the 55 sample went to metagenomics)
UWAR3	pre-dawn-2	JR218_028	15-Oct	24˚44.66	40˚5.30	surf, 12, 49, 66, 115, 172	
UWAR3	pre-dawn-2	JR218_032	16-Oct	22˚35.99	40˚15.95	surf, 16, 53, 72, 124, 187	
UWAR3	pre-dawn-2	JR218_035	17-Oct	19˚43.35	38˚13.81	surf, 15, 49, 66, 115, 173	
UWAR4	pre-dawn-2	JR218_038	18-Oct	16˚48.64	36˚12.40	surf, 13, 43, 58, 100, 150	
UWAR4	pre-dawn-2	JR218_042	19-Oct	14˚55.16	34˚55.32	surf, 11, 37, 50, 87, 130	
UWAR4	pre-dawn-2	JR218_045	20-Oct	11˚49.24	32˚49.45	surf, 8, 27, 37, 64, 96	
UWAR4	pre-dawn-2	JR218_048	21-Nov	8˚38.63	30˚42.50	surf, 9, 28, 38, 66, 98	
UWAR5	pre-dawn-2	JR218_051	22-Oct	5˚20.38	28˚31.28	surf, 10, 34, 46, 79, 118	
UWAR5	pre-dawn-2	JR218_056	23-Oct	2˚47.55	26˚51.28	surf, 10, 34, 46, 79, 119	
UWAR5	pre-dawn-2	JR218_059	24-Oct	-0˚34.76	24˚59.64	surf, 13, 43, 58, 100, 150	
UWAR5	pre-dawn-2	JR218_063	26-Oct	-8˚49.52	24˚59.72	surf, 14, 45, 60, 104, 157	
UWAR6	pre-dawn-2	JR218_066	27-Oct	-12˚50.38	24˚59.89	surf, 14, 45, 60, 105, 157	
UWAR6	pre-dawn-2	JR218_070	28-Oct	-16˚38.26	24˚59.63	surf, 18, 58, 78, 135, 203	
UWAR6	pre-dawn-2	JR218_075	29-Oct	-19˚7.42	25˚59.75	surf, 16, 53, 72, 125, 187	
UWAR6	pre-dawn-2	JR218_079	30-Oct	-22˚47.13	25˚0.55	surf, 16, 53, 72, 125, 187	
UWAR7	pre-dawn-2	JR218_083	31-Oct	-26˚33.43	24˚59.87	surf, 17, 55, 74, 128, 192	
UWAR7	pre-dawn-2	JR218_087	1-Nov	-28˚52.10	26˚2.17	surf, 14, 47, 63, 110, 165	cell trap for tests (RNA etc. 20L)
UWAR7	pre-dawn-2	JR218_091	3-Nov	-33˚46.09	32˚0.19	surf, 9, 30, 41, 71, 100	filters full of bubbles, diatom bloom? stopped using pluronic - as seen in the netting
UWAR7	pre-dawn-2	JR218_094	4-Nov	-36˚10.40	35˚3.25	**XX JOHN XX**	
UWAR8	pre-dawn-2	JR218_097	5-Nov	-37˚57.80	37˚24.24	surf, 6, 21, 29, 50, 76	
UWAR8	pre-dawn-2	JR218_101	7-Nov	-43˚13.60	44˚36.81	surf, 3, 11, 15, 26, 39	

2. Isolation of Syn, Pro and Peuk cultures with the aid of flow-sorting

2a. Sampling strategy

Enrichment cultures and flow-sorting (FACSort) were used on most days to isolate Syn and Peuk cultures. Generally, seawater from surface (97%) and deep (0.1% light depth) samples were pre-concentrated (~ 5-10 X) using 0.2 µm polycarbonate anodisc filters. The concentrates were used to either inoculate selective media (K-medium for Peuk and Pro99 with NH_4 or NO_3 additions for Syn/Pro) or sorted using the FACSort into pre-filtered deep water (0.2 µm filtered water from 200 or 300 m). When multiple distinct populations were observed on cytograms the sub-populations were sorted separately. Sheath fluid was prepared by filtration of deep water (200 or 300 m) through at least a 0.2 µm sterivex filter or similar pre-cooled to < 20˚C on warm days. Sorted samples often contained between 1,000 and 20,000 cells sorted into a combined volume of sheath fluid up to 10 ml. Cultures were incubated on a constant light or light-dark cycle at 20-26˚C at a variety of cool-white fluorescent light intensities.

2b. Preliminary results

Pigmented cultures were obtained for ***Synechococcus*** enrichments and cell-sorted samples from 31 stations.

Cell sorted samples from 39 stations were obtained for picoeukaryotes. 32 samples of concentrated seawater were also collected for further sorting in the lab alongside Fluorescent in situ hybridization work to identify interesting groups.

3. Metagenomics and transcriptomics of Syn and Peuk populations at selected stations

3a. Sampling strategy

Seawater was collected from 2 depths at 9 stations in the oligotrophic Northern and Southern gyres, the equatorial region and at the high-latitude temperate extremities of the cruise (Table 2). Seawater concentrates were collected in Cell Traps (0.22 µm) after size-fractionation (100 µm mesh, 10 µm and 5.0 µm PC filter membranes).

3b. Proposed analyses

DNA and RNA will be extracted from flow-sorted populations of Syn, Pro and Peuk and amplified using a commercial kit (after reverse transcription for RNA). Amplified nucleic acids will then be sequenced to a high depth-of coverage using 454 sequencing at a NERC Molecular Genetics Facilty.

Table 2. Summary of size-fractionated samples for metagenomics and meta-transcriptomics work. Samples were concentrated from 20 l of seawater in duplicate and pre-filtered through 100 µm mesh and 10.0 µm filters. Concentrated samples were extracted in triplicate from 0.22 µm cell traps. The initial concentrates, corresponding to 3-4 l of seawater, were extracted within 30 min.

cryo-box	cast	CTD	date	lat˚ N	lon˚ W	depths (m)	notes
UWAR24	pre-dawn-2	JR218_006	7-Oct	49˚8.96	14˚39.15	6, 49	
UWAR24	pre-dawn-2	JR218_012	9-Oct	42˚40.38	22˚11.70	12, 95	
UWAR24	pre-dawn-2	JR218_025	14-Oct	27˚37.90	37˚1.83	19, 120	
UWAR24	pre-dawn-2	JR218_028	15-Oct	24˚44.66	40˚5.30	12, 115	
UWAR24	pre-dawn-2	JR218_056	23-Oct	2˚47.55	26˚51.28	10, 70	
UWAR24	pre-dawn-2	JR218_070	28-Oct	-16˚38.26	24˚59.63	18, 150	
UWAR24	pre-dawn-2	JR218_083	31-Oct	-26˚33.43	24˚59.87	17, 115	
UWAR24	pre-dawn-2	JR218_091	3-Nov	-33˚46.09	32˚0.19	9, dcm	filters full of bubbles, possible diatom bloom as seen in the netting.
UWAR24	pre-dawn-2	JR218_101	7-Nov	-43˚13.60	44˚36.81	3, 26	

4. Elemental composition analysis of flow-sorted *Syn, Pro* and *Peuk* cells using X-Ray TEM and High Resolution Inductively-Coupled-Plasma Mass Spectrometry (HR ICP-MS)

4a. Sampling strategy

Seawater was collected from up to 4 depths at 24 stations along the transect at the noon CTD. Up to 10 l was collected in acid-washed polycarbonate carboys shrouded in light-proof plastic and immediately processed. Seawater samples were pre-filtered (100 µm mesh and 10.0 µm PC) and the < 3.0 µm fraction was concentrated in Cell Traps (0.22 µm pore size). All filter-holders, filters and peristaltic pump tubing was saoked in 5% trace-clean HCl, rinsed with MilliQ and pre-wahsed with ~ 500 ml of seawater sample. Concentrated cells were extracted at least three times from each trap with the first extraction, corresponding to 3-5l of seawater, after 30-45 min of concentration. Concentrated cells were immediately flash frozen in Liq. N_2 and transferred to -80˚C.

4b. Proposed analyses

Micro-elemental composition (S, P, Fe, Zn, Co, Cu, Mo) of flow-sorted Syn, Pro (and Peuk where possible) as well as bulk samples will be determined with an Agilent 7500cx HR-ICPMS instrument equiped with an octopole reaction system (ORS). For the trace metals to be tested the instrument has limits of detection in the low ppb to ppt range, as verified by

trace-metal controlled pre-cruise optimisation trials carried out with cyanobacterial cultures. To complement this analysis we will also determine the composition of 'macro' elements (C, N, P, Na, Mg, K, Cl), as well as Fe and other trace metals, in single picocyanobacterial cells using XRay-TEM. This work will provide fundamental knowledge on the trace-metal physiology of members of the picocyanobacterial genera, ***Synechococccus*** and ***Prochlorococcus*** and link directly to data obtained from the assesment of community structure (outlined in section 1).

Table 3. Summary for elemental composition analysis samples. Replicate samples were concentrated from up to 10l of seawater from 4 light-depths (97%, 55%, 1.0% and 0.1%), and flash frozen in 1.6 ml aliquots.

cryo-box	cast	CTD	date	lat˚ N	lon˚ W	depths (m)	notes
UWAR21	noon	JR218_004	6-Oct	49˚22.31	11˚23.44	10, 40	
UWAR21	noon	JR218_007	7-Oct	48˚52.05	16˚11.65	surf, 49	
UWAR21	noon	JR218_010	8-Oct	45˚39.85	19˚35.22	8, 65	
UWAR21	noon	JR218_017	11-Oct	35˚18.8241	28˚27.9797	surf, 25, 44, 156	
UWAR21	noon	JR218_020	12-Oct	32˚29.40	31˚42.60	surf, 22, 39, 157	
UWAR21	noon	JR218_030	15-Oct	24˚44.29	40˚04.20	surf, 27, 115, 172	changed sampling to 97%, 55%, 1.0%, 0.1%
UWAR21	noon	JR218_033	16-Oct	21˚40.40	39˚35.78	surf, 30, 124, 187	
UWAR21	noon	JR218_040	18-Oct	16˚48.64	36˚12.40	surf, 24, 100, 150	
UWAR22	noon	JR218_043	19-Oct	14˚05.597	34˚21.605	surf, 21, 87, 130	
UWAR22	noon	JR218_046	20-Oct	10˚53.50	32˚12.38	surf, 8, 64, 96	
UWAR22	noon	JR218_049	21-Nov	07˚39.76	30˚03.56	surf, 16, 66, 99	flow cam shows plenty of trichodesmium from netting
UWAR22	noon	JR218_057	23-Oct	01˚49.83N	026˚12.92	surf, 10, 79, 119	
UWAR22	noon	JR218_060	24-Oct	01˚37.75	024˚59.69	13, 100,	only 2 samples
UWAR22	noon	JR218_061	25-Oct	-06˚03.14	024˚58.63	surf, 21, 87, 130	
UWAR22	noon	JR218_064	26-Oct	-09˚58.52	024˚59.96	surf, 14, 105, 157	fresh pp tubes (Fisherbrand)
UWAR22	noon	JR218_067	27-Oct	-13˚59.71	024˚59.71	surf,14, 105, 157	
UWAR22	evening	JR218_068	27-Oct	-14˚59.60	024˚59.66	20m,	protein cell trap good yield x 2
UWAR22	noon	JR218_072	28-Oct	-16˚52.52	024˚59.77	surf, 33, 135, 203	
UWAR22	noon	JR218_076	29-Oct	-20˚16.99	25˚00.07	surf, 30, 125, 187	
UWAR23	noon	JR218_080	30-Oct	-23˚56.07	24˚59.96	surf, 16, 125, 187	
UWAR23	noon	JR218_085	31-Oct	-26˚43.33	24˚59.87	surf, 31, 128, 192	
UWAR23	noon	JR218_088	2-Nov	-32˚10.77	29˚49.53	surf, 25, 105, 158	1st extract at 50 min
UWAR23	noon	JR218_095	4-Nov	-36˚10.38	35˚03.25	surf, 15, 65, 98	good yield for 2 samples each
UWAR23	noon	JR218_098	5-Nov	-38˚45.73	38˚27.53	surf, 12, 50, 76	
UWAR23	noon	JR218_099	6-Nov	-41˚28.611	42˚08.369	surf, 12, 49*, 74	another diatom bloom?, gelatinous brown stuff, 100µ mesh clogged, low yield in cell trap

5. **Phage samples and experiment**

Samples were taken from three sites along the transect, with the northern and southern gyres as well as the equatorial region represented. The aim of the experiment was to enumerate the percentage of ***Synechococcus*** affected by phage in the natural environment. To achieve this, samples were incubated with Mitomycin C, in order to induce lysogeny, for 24 hours. Sub samples were taken every 6 hours and filtered onto both 0.2 and 0.02µm filters. A comparison of these samples would then be compared with a negative control (seawater taken at the same time without the addition of Mitomycin C) and used to assess the proportion of syn cells which were infected by phage. A small amount of water was stored at 4 degrees every 6 hours so the total number of cyanophage could be assessed. Samples were filtered every other day onto a 0.2µm filter in order that RING-FISH can be undertaken to assess the number of infected cells as well as doing TSA_FISH to calculate the number of Syns and Pros present in the sample.

UKORS TECHNICAL CRUISE REPORT

Ship: James Clark Ross

CRUISE No:	**JR218**
DATES:	**3rd Oct 2008 – 10th Nov 2008**
PRINCIPLE SCIENTIST	**Malcolm Woodward**
UKORS TECHNICIANS	**Terry Edwards (TLO)** **Dave Teare**

Contents:

The completion of this cruise report is to be managed by the designated TLO for each cruise. The TLO should ensure he/she has access to an electronic copy of the report prior to the vessel sailing.

The mechanical, instrumentation and computing technicians are required to complete their relevant section of the report i.e. Sec. 2 / 3 / 4 / 5, and forward their reports in electronic format to the TLO prior to the end of the cruise. The TLO is to collate the individual reports and E-mail the complete report back to the OED-Administrative group e-mail address (oedadmin@soc.soton.ac.uk) not less than 48hrs before cruise completion.

In extraordinary circumstances when email is unavailable, the TLO is to make contact by phone or fax and report any critical operational issues that need priority resolution. In such cases the report is to be delivered (in electronic format) immediately on return to SOC. Sections 1–5 will constitute the whole technical report and will be posted on the shared drive for general distribution.

The TLO is to provide a separate TLO report which is to be sent direct to Head UKORS (gerw@soc.soton.ac.uk), UKORS Operations manager (cdy@soc.soton.ac.uk), and the UKORS Equipment manager (gmb@soc.soton.ac.uk). This section is 'Management in confidence' and will remain within UKORS.

To ensure the report remains comprehensive and current, all staff are requested to add tables for additional equipment as you see fit. Please make a note of any additions or modifications to the report in the comments table at the end of each section, this will enable the master report to be updated to reflect the changes for future use.

Section 1 is to be completed by the TLO giving a brief outline of the cruise profile.

Section 2, 3, 4 and ***5*** are to be completed by staff from the relevant disciplines and forwarded to the TLO.

The TLO is to send the report back to SOC completed by all disciplines with all sections merged into one report.

United Kingdom Ocean Research Services
Southampton Oceanography Centre
European Way
Southampton SO14 3ZH
United Kingdom

Telephone: +44 (0)23 8059 6109
Fax: +44 (0)23 8059 6066
Email: cdy@soc.soton.ac.uk

Cruise Outline

Please give a brief outline of cruise activities covering the following areas:

Science discipline:

Chemistry, Biology and Physics

General geographical location of cruise:

Transect between UK and Falklands, including stations at NAG and SAG

University / institute fronting the cruise:

Plymouth Marine Lab (PML)

Mobilisation port / de-mobilisation port:

Immingham (UK) to Stanley FI

General outline of cruise activities and equipment:

Pre dawn station consisting of 2 CTD dips and 2 plankton net casts. Noon station consisting of CTD and optics rig cast. MVP to be towed for as much of the transit as possible. Occasional deep CTD and LADCP dips to full ocean depth.

Mechanical Portable Equipment Reports

Cut and paste additional sections as required by i) Unprotect document in Tools menu ii) Cut & Paste section as normal iii) Re-Protect document.)

Equipment name: LIQUID N2 GENERATOR			
Group/Project group owning the equipment:	PORTABLE SYSTEMS	Cruise Number:	JR218
Name of technician completing report:	T.EDWARDS	Date:	6 November 2008
Was the cruise completed with the equipment in good working order: YES			
Faults rectified in use: Replaced hose to dewar			
Faults to be addressed for next cruise requirement (Cruise): See comments			
Comments: Ran air compressor for 24hrs to purge, helium compressor gauges both reading 130psi, ALSH suspects leak between dewar head and compressor. Tiny leak found on the front cryo hose. Replacement purged and fitted. Cryo unit recharged to 195psi and system tested. Then purged with air overnight before full startup. System operated well throughout			
Spares Required: 1x braided hose, battery for O2 detector			

Equipment name: RN CONTAINER			
Group/Project group owning the equipment:	PORTABLE SYSTEMS	Cruise Number:	JR218
Name of technician completing report:	T.EDWARDS	Date:	6 November 2008
Was the cruise completed with the equipment in good working order: YES			
Faults rectified in use: Icing of AC unit caused by unit being used too cold.			
Faults to be addressed for next cruise requirement (Cruise):			
Comments: emergency door allowed water ingress. Possibility of fitting a gland to allow fitting of comms on JCR where alarm board is no use.			
Spares Required: none			

Instrumentation Report

Instrumentation Portable Equipment Reports

(Cut and paste additional sections as required by i) Unprotect document in Tools menu ii) Cut & Paste section as normal iii) Re-Protect document.)

Equipment name: MOVING VESSEL PROFILER			
Group/Project group owning the equipment:	SENSORS AND MOORINGS	Cruise Number:	JR218
Name of technician completing report:	T.EDWARDS	Date:	6 NOV 2008
Was the cruise completed with the equipment in good working order: NO			
Faults rectified in use: Water ingress into control and power enclosures. Caused failure of 10A24v power supply and also the suspected cause of some later control/interface comms issues. Power supply was bypassed using an external source. Inner sheave limit switch faulty, replaced Bridle bent during 14kt tow, bridle straightened and reinforced by motorman and used throughout. Oxygen sensor failed, replaced with spare Oxygen sensor cable failed dragging down all analogue channels. Scrolling went awol, Had some success winding it on from mooring winch, but vertical drop with 80kg put a strange flat spot on 10 turns on one side of the drum. Hydraulic leaks on motor drive and emergency recovery box			
Faults to be addressed for next cruise requirement (CruiseD338): 24 v power supply, spare bridle to be reinforced, O2 sensors require cal check, scrolling.			
Comments: The system produced very high quality data and did almost 400 profiles, typically to 240m at 12.5 kts. The system needs monitoring continuously as there are numerous interlocks and comms checks and spurious signals that will abort profiling. Daily maintenance and checks were reduced to visual inspections from about halfway into the trip allowing more profiles. The early water ingress was the cause of a lot of the downtime and is easily remedied. The system showed what it is capable of given enough attention			
Spares Required: Control boards, 24v PS,			

Equipment name: LADCP			
Group/Project group owning the equipment:	Sensors and Moorings	Cruise Number:	JR218
Name of technician completing report:	T.Edwards	Date:	8 Nov 08
Was the cruise completed with the equipment in good working order: Yes			
Faults rectified in use: None			
Faults to be addressed for next cruise requirement (CruiseJr194): None			
Comments: ADCP (RDI 300Khz Workhorse) Five deep casts were performed with the ADCPs (casts 29, 39, 52, 71 and 84). All five casts recorded data, however there are several points worth noting. 1) All casts gave fairly low echo intensity returns below approximately 800m. The seabed, sea surface and near surface returns however looked quite normal. The low value returns, may be due to reduced scatterers at depth. 2) Cast 39, although this was the longest cast with the greatest number of ensembles, it gave the shortest data set when run through WINADCP, approximately 1 hour. At present there is no explanation for this. Subsequent casts appear to be correct. 3) Three casts show relatively high rotation rates on the down cast which are not present on the up cast. Ser no 4275 upward looking Master Ser no 1855 downward looking Slave			
Spares Required:			

Equipment name: FRRF			
Group/Project group owning the equipment:	S and M	Cruise Number:	JR218
Name of technician completing report:	T.Edwards	Date:	8 Nov 08
Was the cruise completed with the equipment in good working order: Yes			
Faults rectified in use: None			
Faults to be addressed for next cruise requirement (Cruise): none			
Comments: Three units were employed on the following, CTD, PML optics rig and in the ship's underway non-toxic supply. There were no reported problems with the instruments. Three CTD casts were lost due to the memory card becoming full. Ser no 182043 CTD Ser no 182042 PML Optics Rig Ser no 182041 Underway surface sampling			
Spares Required:			

UNDERWAY PHYSICS

Stuart Painter, Jo Hopkins

An Introduction

Previous AMT cruises have successfully focussed upon the biogeochemistry of the Atlantic Ocean and have as a consequence tended to be very light on the acquisition of more physically orientated datasets. Under Oceans2025 a concerted effort has been made to include more physics on the AMT cruises and AMT18 was the first cruise on which this was attempted. In many ways this was an experimental approach in replicating the established processing architecture that has been heavily used on RRS ***Discovery***, namely the PEXEC/PSTAR processing framework. Fortunately, the basics needed for this purpose have been available on the RRS ***James Clark Ross*** (JCR) for a number of years and have been maintained, though it is worth noting that the JCR appears currently equipped only with PEXEC version 5 and has not been updated to the latest version (version 6). In anticipation of this and other problems we brought with us a Solaris unix workstation ("Crozet") equipped with PEXEC version 6 and processed all of the following under this installation making changes to the processing scripts as and where necessary.

A number of objectives were sought during the cruise which can briefly be summarised as 1) the acquisition of high quality navigation data, 2) the acquisition and processing of vessel mounted Acoustic Doppler Current Profiler data (ADCP), 3) onboard CTD processing and 4) the deployment and analysis of data from a towed instrument platform (the Moving Vessel Profiler – MVP). These objectives were met to varying degrees and further details are provided in the relevant sections below.

Navigation, Ship's Attitude and Position

Stuart Painter, Jo Hopkins

Meaningful water velocities from the vessel-mounted acoustic doppler current profiler (ADCP) can only be obtained when the ADCP data are corrected for the ship's direction, speed and attitude; in effect removing the ship's motion from the ADCP's initial estimate of water column movement. This is achieved through the careful incorporation of navigation information from a variety of sources.

Ship's position and navigation data

The ship's best determined position was calculated by the NMF process 'bestnav' which has been replicated on the JCR. The 'bestnav' datastream represents the combined output from several sensors (Glonass, Ashtech, GPS etc), thus ensuring continued navigation information in the event of one sensor failing. The main data source was the ships GPS SeaTex system, which provides the most accurate position. Data were transferred daily from the 'bestnav' data stream to the PSTAR absolute navigation file 'abnv2181' for use in PSTAR processing. GPS data ('seatex' data stream) were also transferred and processed daily. N.B. the 'bestnav' estimate of position consists of a reduced resolution 30 second average ships position whilst the GPS data is at a higher 1 second resolution.

Whilst it is generally considered that a ship's gyro instrument is the most reliable indicator of direction and provides essential information for correcting ADCP velocities to earth co-ordinates, the gyro data (as a discreet data stream) was not needed during this cruise. This was because the nmea navigation datastream available from the SeaPath system on the JCR is considered better than a similar Ashtech minus gyro product, and because the navigation feed into the ADCP already contained gyro information. Thus a pure gyro file was not needed for the processing of the ADCP data. However for completeness the gyro data stream 'gyro' was processed as described below.

The PSTAR scripts used for processing navigation datastreams were:

navexec0: transferred the data steam 'bestnav' to PSTAR format. Ship's velocities were calculated from position and the distance run calculated after appending to the master abnv2181 file.

gpstexec0: transferred the 'seatex' GPS data stream to PSTAR format. Data with "pdop" (position dilution of position) outside the range 0-7 were removed. Further edits were made to remove outliers and gaps interpolated before the file was appended to the master file gpst21801 and the distance run calculated. A 30 second average file gpst21801.30sec was also created.

gyroexec0: transferred data from the 'gyro' stream to PSTAR format. Headings outside the range 0-360° were deleted and the file appended to the master gyr21801 file.

Ships heading and attitude

The ship's attitude was measured every second by the 3D GPS Ashtech navigation system. Four antenna (two on the boat deck, two on the bridge top) measured the phase difference between incoming satellite signals from which the ship's heading, pitch and roll were determined. Ashtech data were read from the data stream 'gps_ash' into PSTAR.

ashexec0: transferred data from the 'gps_ash' data stream to PSTAR binary file ash218***nn***, where ***nn*** is a daily processing stamp.

ashexec1: merged ashtech and gyro heading data and calculated the ashtech – gyro heading difference (a-ghdg). All values were set between -180 – 180°

ashexec2: edited the data outside the following ranges

heading 0 - 360
pitch -5 - 5
roll -7 - 7
attitude flag -0.5 - 0.5
measurement RMS error 0.00001 - 0.01
baseline RMS error 0.00001, 0.1
ashtech – gyro heading -10, 10

Heading differences greater than 1.0° from a 5 point running median were removed. Data were then averaged to 2 minute intervals and further edited to remove data cycles where

pitch -2. - 2.
mrms, 0 - 0.004
a-ghdg, -10 – 10

Results were merged with the gyro file and ships velocities calculated.

As Ashtech data were not needed for use in the calculation of current speed and direction detailed investigation of the data was not undertaken during this cruise. However in the unlikely event of a problem being identified in the ADCP data, it has been archived so that an Ashtech-gyro product can be determined if necessary.

75 kHz "Ocean Surveyor" ADCP

Stuart Painter, Jo Hopkins

The vessel mounted RDI Ocean Surveyor 75 kHz ADCP was configured to sample over 100 bins of 8 m depth at 120 second intervals. The PC was running RDI software VmDAS v1.42. Gyro heading and GPS Seatex location and time are automatically fed into the software. The software logs the PC clock time, stamps the data (start of each ensemble) with that time, and records the offset of the PC time from GPS time. This offset is automatically applied to the ADCP data in the processing path before merging with the navigation data. The instrument was operated in water tracking mode for the majority of the cruise with the exception of the period crossing the NW European continental shelf when the bottom was shallow enough (<200m) to provide calibration of the instrument.

Calibration of the Ocean Surveyor was undertaken using the bottom track mode and was conducted during the run out from Immingham, though the English Channel and out over the continental shelf. The data from the ADCP proved to be rather noisy and whilst acceptable values of the misalignment angle (□□ = -0.1113) and the scaling factor (A = -1.01605) could be obtained from quiet sections of the data record this does not adequately describe the large standard deviation surrounding the mean values (Figure 1), or the recurrent problems encountered early in the cruise. The origin of the noise is believed to be in the Seatex navigation data stream that is fed into the ADCP PC during data acquisition, but detailed confirmation of this suspicion was not possible. Further investigation of this and of the possible interference from other ship fitted acoustic systems (see below) is required.

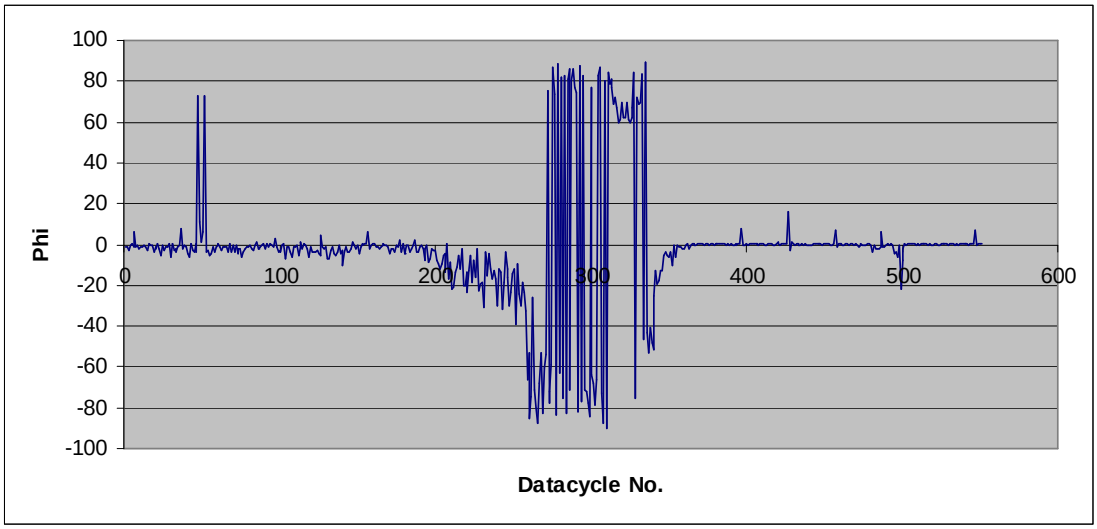

Figure 1: Example of the problems encountered whilst trying to calibrate the Ocean Surveyor 75 kHz ADCP. Several small spikes in the estimate of the misalignment angle (□□ can be seen at the start and end of the record but a period of considerable disturbance can also be seen between data cycles 200 and 350.

Due to concerns over the large standard deviation of the misalignment angle and scaling factor, and that the calculated values were not significantly different to 0 and 1 respectively, we decided that "default" values would be used for the misalignment angle (□□ = 0) and for the scaling factor (A = 1). As was noted by John Allen, who was onboard during the calibration period, the relatively poor calibration is typical of ships such as the ***James Clark Ross***, where the ADCP is often situated behind a glass sheet to protect it during periods when the ship is operating in, or near ice.

Having thus calibrated the ADCP with an assumed offset angle of 60^{o} set in the VmDAS software (to compensate for the positioning of the ADCP against the hull) we were somewhat later surprised to find that the offset had been reset to 60.08^{o} in the software. This occurred following the acoustic trials period conducted along the shelf break when numerous configuration files were being tested by BAS personnel to synchronise the ship fitted acoustic systems. A minor oversight led to the small difference in the offset angle being introduced which upon discovery was left set in the VmDAS software at 60.08^{o}.

During the acoustic trials an unusual interference was often observed in the ADCP data. During processing we became aware of periods of time when large spikes in current velocities were present. Further investigation revealed that these spikes would appear at exactly quarter past the hour for several hours at a time and then vanish, only to reappear at a later time. The regularity of the signal is very strange as we would expect acoustic interference to be present continuously. Whilst we could not identify its origin (navigation, swath, echo sounder etc) it is telling that when the swath bathymetry PC fell over and lost its settings the interference disappeared.

The ADCP worked continuously for almost the entire duration of the cruise. There were however four periods when no data was collected. The first two of these relate to an unexpected problem with the PC that VM-DAS was operating on and remain unresolved. On Jday 300, and again on Jday 301, the VM-DAS software simply stopped working and closed introducing a 1 hour and 3 hour gap into the data record respectively. The third data gap of 45 minutes on Jday 306 relates to a ship wide power outage, during which time all systems were non-operational. The fourth gap in data collection on Jday 311/312 and lasting 19 hours, relates to a problem with writing the data to the network. This process was interrupted in the early afternoon of Jday 311, and updated versions of the data files were not transferred to the network. However the secondary backup on the local ADCP PC continued to update until the file (jr218074) was closed manually on the morning of Jday 312. It is hoped that the data can be recovered from the local backup of this file, providing an updated .STA file spanning the entire duration of the acquisition period.

Data Processing

All ADCP data files were written locally to the PC hard disk and to a network directory (/data/cruise/jcr/2008100/adcp) with a .STA extension (e.g. jr218036_000000.STA). Sequentially numbered files were created whenever data logging was stopped and restarted. Although the software was set to close files when they reached 100 Mb in size data logging was manually stopped and restarted once every 24hrs. Once the current file had been stopped and a new file initialised processing of the data was performed using the following scripts specifically modified for the purpose.

S75exec0: data read into PSTAR format from RDI binary file. Water track velocities written into 'sur…' files, bottom track velocities into 'bot…' files. Velocities scaled to cm s^{-1} and amplitude by 0.45 to dB. The time variable was corrected to GPS time by combining the PC clock time and the PC-GPS offset. The depth of each bin was determined from the user supplied information. Output files were of the format sur218***nn***.raw and bot218***nn***.raw.

S75exec1: data edited according to status flags. Velocity replaced with absent data if variable 2+bmbad was greater than 25% (this being a measure of the number of times more than 1 beam was bad).

S75exec3jr: This was a specially written script for use on the JCR where heading information comes from the SeaPath navigation data stream which (according to ships TLO) is considered to be better than similar information derived from the Ashtech and gyro datastreams. This script applies the misalignment angle (□) and scaling factor (A) to both water track and bottom track files (if both are present). Variables are renamed and reordered to preserve original data files. Output files sur218***nn***.cal and sbt218***nn***.cal.

S75exec4jr: This is a modified version of surexec4 which uses SeaTex navigation for spot values and bestnav for general positioning (n.b. 30 second bestnav). The script merges the ADCP data with the GPS navigation file (gpst21801) created by gpstexec0. Ship's velocity was calculated from spot positions taken from the gpst21801 file and applied to the ADCP velocities. The end product is the absolute velocity of the water. The time base of the adcp profiles was then shifted to the centre of the 2 minute ensemble by subtracting 60 seconds and new positions were taken from the bestnav file (abnv2181). Output files sur218***nn***.abs (and if appropriate sbt218***nn***.abs).

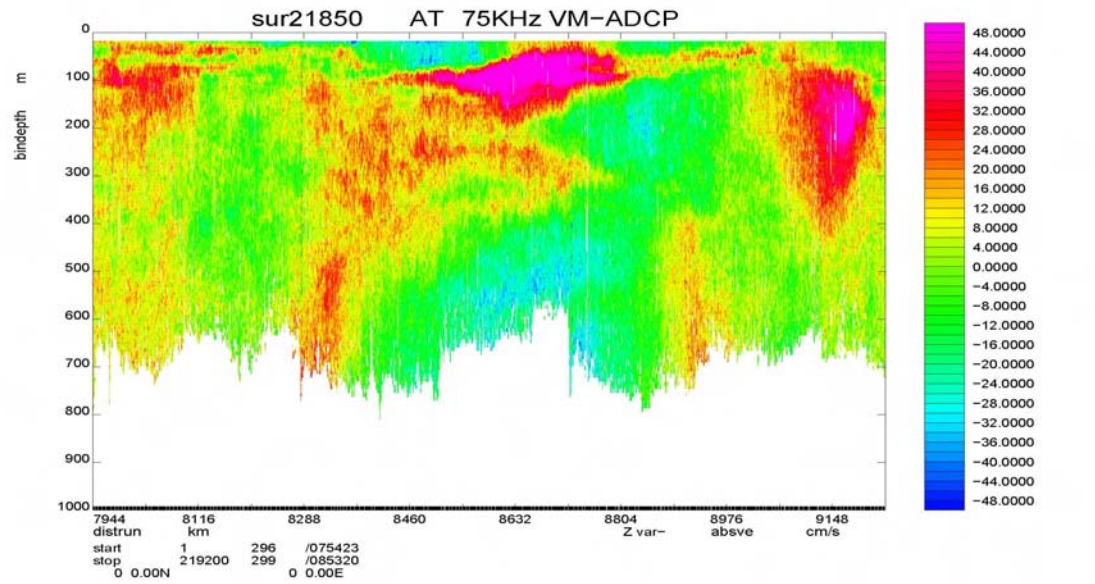

Figure 1: Snap shot of the east-west current vectors across the equator between 5^{o}N (left hand side) and 5^{o}S (right hand side). The complex equatorial current system is revealed as a series of distinct currents alternating between eastward and westward flows at times in excess of 50 cm s^{-1}.

Processed File Numbers				
Sur21803.abs		Sur21841.abs		Sur21860.abs
Sur21811.abs		Sur21842.abs		Sur21861.abs
Sur21812.abs		Sur21843.abs		Sur21862.abs
Sur21818.abs		Sur21844.abs		Sur21863.abs
Sur21820.abs		Sur21845.abs		Sur21864.abs
Sur21821.abs		Sur21846.abs		Sur21868.abs
Sur21822.abs		Sur21847.abs		Sur21869.abs
Sur21823.abs		Sur21848.abs		Sur21870.abs
Sur21832.abs		Sur21849.abs		Sur21871.abs
Sur21833.abs		Sur21850.abs		Sur21872.abs
Sur21834.abs		Sur21851.abs		Sur21873.abs
Sur21835.abs		Sur21852.abs		Sur21874.abs
Sur21836.abs		Sur21853.abs		Sur21875.abs
Sur21838.abs		Sur21854.abs		Sur21876.abs
Sur21839.abs		Sur21858.abs		
Sur21840.abs		Sur21859.abs		

Table 1: List of processed ADCP files relevant to the cruise (excludes Acoustic Trials period and incomplete files)

Moving Vessel Profiler CTD Data

Stuart Painter, Jo Hopkins, Terry Edwards, Dave Teare

During the cruise the Brooke Ocean Technologies Moving Vessel Profiler (MVP) was deployed for up to 22 hours at a time on 22 occasions (Table 1). The MVP performed extremely well, a testament to the hard work that has recently gone into the complete strip down and rebuild of the MVP system by the National Marine Facilities group at Southampton. A few minor problems were encountered during the cruise including the failure of the dissolved oxygen and fluorometer sensors on 3 tows but this was easily remedied via a change of sensors. Interestingly, the MVP had been used on Discovery Cruise D332 immediately prior to AMT18 and in the MVP report for that cruise by Roz Pidcock et al***, it was suggested that an imminent failure of the oxygen sensor could be detected in the data. As this did indeed occur early on during AMT18 it suggests that there is sufficient warning of impending instrument failure to allow for the change of sensor before total failure and loss of data occurs.***

A more serious problem was encountered after only the second deployment when the tow bridle was bent preventing redeployment of the MVP for almost a week whilst the cause was investigated. A similar problem was reported by Jeff Benson during AMT12. The consensus is that the tow bridle is not able to withstand the forces applied to it when the ship is travelling at full speed (12.5 knots). Fortunately a second heavier gauge bridle was available and exchanged for the bent one thereby allowing deployments to continue. Towards the end of the cruise a problem related to the scrolling of the cable drum also became an issue that prevented the continued deployment of the MVP.

Data

The BOT (Brooke Ocean Technologies) MVP 300, carried an AML micro CTD (Conductivity, Temperature, Depth) instrument (serial number 7027), a Chelsea Technologies Group MiniTracka II fluorometer, an AML micro dissolved oxygen sensor with an Idronaut sensing head (which does not include a temperature sensor) and two Satlantic (OCR507) light sensors (one PAR and one TIR).

The data were recovered, in near real time, through the BOT software on a PC in the main lab. A series of files are created after each down/up cycle. The principal file containing most of the data has the suffix '.m1'. Eight other files were written, most duplicating some of the data streams in the '.m1' file but in a specific format for feeding into other instruments (e.g. swath systems). The PAR and TIR data were not in the '.m1' file and only seem to be present in a raw counts instrument file. No attempt was made to read the PAR or TIR data in during the cruise, but the raw files were archived with all the other cruise data for later reference if required.

With the exception of the 'user variables' channels, the data in the '.m1' files are in engineering units 'calibrated' using pre-set coefficients stored in the BOT software. The fluorimeter and the oxygen sensor were connected to the 'user variables' channels, ANLG1 and ANLG2 respectively. The sensors sample at 24 Hz, and each data file (.m1) is time stamped with GPS time in the header only.

Processing Steps

The processing followed that developed by John Allen (NOC) on ***Discovery*** cruise D306 and used subsequently on cruises D309 & D332. All PC files were transferred to the ship's UNIX computer system by ftp over the ship's ethernet.

mvpexec0: This reads the '.m1' data files, e.g jr218_0001.m1, into PSTAR binary format. The start time of each file is extracted from the header information and placed in the PSTAR headers, then a relative 24 Hz time variable for each PSTAR file is created. Variables were calibrated as appropriate, and a temperature difference variable was created. The data were despiked and 1Hz averaged files were created. Finally the script appended the 1Hz files into a 1Hz survey file, e.g. mvp218***nn***.raw where ***nn*** is the tow number.

mvpexec1: The main steps to mvpexec1 were firstly ***pcalc*** to apply a temperature lag correction (see below). Secondly the equation of state was used to calculate potential temperature, salinity and density. This second step was conveniently done using ***peos83***, a PSTAR function specifically written for this purpose.

No editing of surface spiking was attempted as the MVP controls had been set such that the vehicle was typically parked at a depth of 6 m and rarely got closer than 2-3 metres from the surface. For most of the cruise tows were made in calm water conditions.

Temperature Correction

It is necessary to make a correction for the small delay in the response of the CTD temperature sensor for two reasons. Firstly, to obtain a more accurate determination of temperature for points in space and time. But, more importantly to obtain the correct temperature corresponding to conductivity measurements, so that a sensible calculation of salinity can be made.

A lag in temperature is apparent in the data in two ways. There is a difference between up and down profiles of temperature (and hence salinity) because the time rate of change of temperature has opposite signs on the up and down casts. The second manifestation is the "spiking" of salinity as the sensors traverse maxima in the gradients of temperature and salinity. The rate of ascent and descent of the MVP is greater (up to ~ 6 m s^{-1} during descent and at the beginning of ascent) than that of a lowered CTD package, thus the effects of the temperature lag are more pronounced. Thus, the following correction was applied to the temperature during ***mvpexec1*** before evaluating the salinity

$T_{corr} = T_{raw} + \tau.\Delta T$ where ΔT is defined above and τ □□is constant (units of second).

The best value of τ was chosen so as to minimise the difference between up and down casts and noise in the salinity profile. Unlike previous cruises where the MVP has been used we found that the best value of □ was not constant and varied throughout the cruise. This may be due to the extensive nature of the deployment during this cruise (22 tows and 5300 km covered), issues surrounding the stability of the AML micro CTD and/or the varied oceanographic conditions sampled. Previous cruises with successful deployments of the MVP are limited but during cruises D306, D309 and D332 □ was determined to be 0.12, 0.15 and □□□□□respectively. It is noteworthy that D332 occurred immediately prior to AMT18. We found that □□□varied from 0.2 – 0.15. The variation appeared to be fairly linear and suggests that the CTD stabilises over time (Table 1).

Salinity calibration

During the MVP tows, surface salinity samples were taken from the ship's non-toxic water supply at the tap in the cross lab. Salinity samples were measured throughout the cruise but due to limited personnel a complete calibration of the MVP salinity data was not possible whilst onboard. This will be addressed upon return to shore. Initial indications suggest however a very good match between underway salinity results and the MVP (Figure 1).

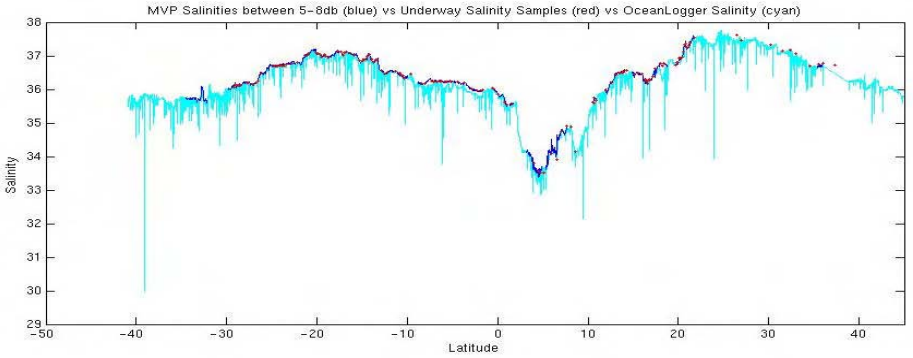

Figure 1. Comparison between MVP surface salinity (dark blue), underway salinity (red) and Ocean Logger salinity (cyan). There is generally a very good fit between the three data sources although much remains to be done to calibrate the various sensors and despike the ocean logger data.

Tow No	Date (Jday)	App start position	App end position	Tow Length (km)	Tow Duration (hrs:mins)	(second)	Problems
1	Oct 8th (282)			58	02:15	0.2	
2	Oct 11th (285)	35 49.92N 27 55.91W	35 29.10N 28 17.92W	57	02:58	0.2	Tow bridle bent
3	Oct 16th/17th (290/291)	21 40.44N 39 37.76W	19 49.68N 38 18.77W	246	13:18	0.19	
4	Oct 17th/18th (291/292)	18 47.43N 37 33.91W	16 53.13N 36 15.74W	256	13:44	0.18	
5	Oct 18th/19th (292/293)	16 47.01N 36 10.41W	14 58.42N 34 57.87W	243	13:04	0.19	O_2 sensor failed
6	Oct 19th/20th (293/294)	14 05.18N 34 19.33W	11 53.32N 32 52.68W	295	13:47	0.18	O_2 sensor failed
7	Oct 20th (294)	10 53.49N 32 12.38W	10 40.85N 32 03.56W	32	01:28	0.18	O_2 sensor failed Fluorometer failed
8	Oct 21st/22nd (295/296)	07 39.75N 03 03.56W	05 23.39N 28 34.61W	300	13:49	0.17	
9	Oct 22nd/23rd (296/297)	05 06.41N 28 22.13W	03 09.57N 27 06.05W	229	10:30	0.17	
10	Oct 23rd (297)	01 48.85N 26 12.22W	01 18.54N 25 52.56W	70	03:11	0.15	
10b	Oct 23rd/24th (297/298)	01 10.67N 25 46.92W	08 27.43N 24 59.93W	213	09:56	0.15	
11	Oct 24th/25th (298/299)	01 37.88S 24 59.73W	05 55.80S 25 00.07W	481	22:40	0.15	
12	Oct 25th/26th (299/300)	06 04.98S 24 58.33W	08 45.39S 25 00.01W	300	13:50	0.15	
13	Oct 26th/27th (300/301)	10 01.40S 24 59.99W	12 41.42S 25 00.10W	303	13:53	0.16	
14	Oct 27th (301)	12 52.03S 24 59.41W	13 49.95S 25 00.05W	113	05:08	0.15	
15	Oct 27th/28th (301/302)	14 02.57S 24 57.72W	16 27.16S 24 59.96W	273	13:23	0.15	
16	Oct 28th/29th (302/303)	16 53.96S 24 57.49W	18 59.60S 24 59.86W	240	11:56	0.15	
17	Oct 29th/30th (303/304)	19 09.11S 24 58.92W	22 43.91S 25 00.23W	419	21:23	0.15	
18	Oct 30th/31st (304/305)	22 48.65S 25 00.49W	26 28.42S 25 59.87W	412	21:09	0.15	
19	Oct 31st/Nov 1st (305/306)	26 34.72S 24 58.76W	28 46.22S 25 54.00W	264	12:22	0.15	
20	Nov 1st (306)	28 54.45S 26 05.92W	29 41.79S 27 03.48W	136	07:10	0.15	
21	Nov 2nd/3rd (307/308)	32 13.11S 29 51.79W	33 41.10S 31 53.19W	256	11:42	0.15	
22	Nov 3rd (308)	33 48.16S 32 01.98W	34 21.42S 32 44.35W	110	05:00	0.15	
TOTAL				**5306**	**257:36**		

Table 1: Summary of the MVP deployments during AMT18

Early results

The MVP tows were made at varying spatial resolutions due to variations in ship speed and in the profiling rate. The contoured parameters were created after gridding the MVP data in a variety of ways using ***pgrids*** (e.g. 8 metre by 6 km bins, 8m by 8 km bins 8 m by 10 km bins etc). This varied gridding structure may need to be revisited following the post cruise analysis of the data. Nevertheless, the initial results are intriguing and reveal considerable variability in all measured parameters (Figures 2-6). Readily apparent is the variability in fluorescence along the AMT transect, the apparent connection between the North and South Atlantic via a narrow tongue of salinity across the equator, and important differences between the North and South Atlantic in general.

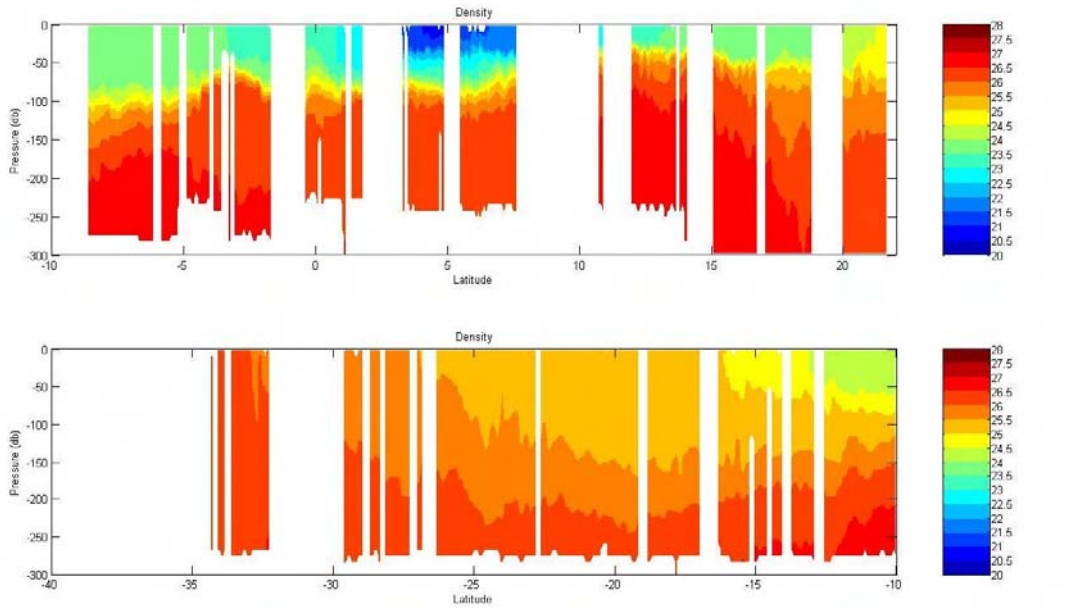

Figure 2: Density section for MVP tows 3-22 (units in kg m^{-3}). The upper panel shows the region between 10°S and 23°N, the lower panel shows the region from 10°S to 40°S.

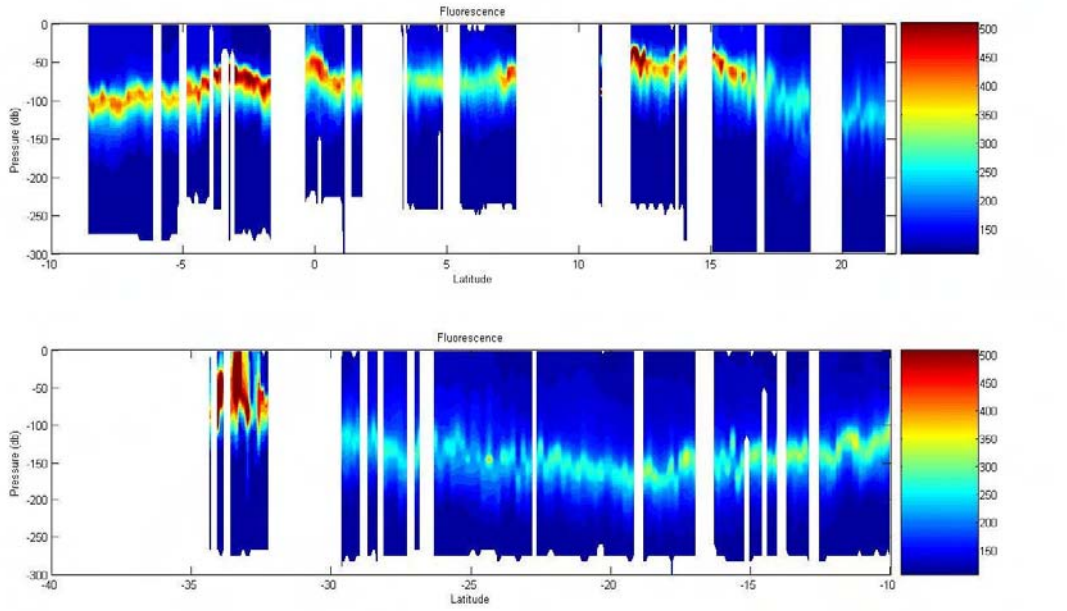

Figure 3: Fluorescence section (as a proxy for chlorophyll) for MVP tows 3-22 (units in millivolts – calibration to be determined).

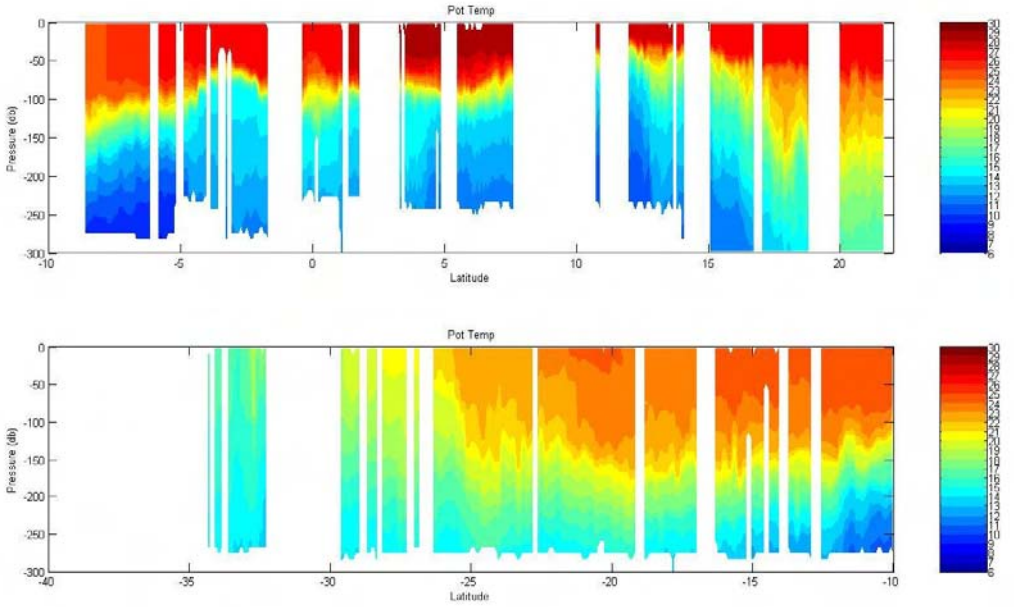

Figure 4: Potential temperature section for MVP tows 3-22 (units in ^{o}C)

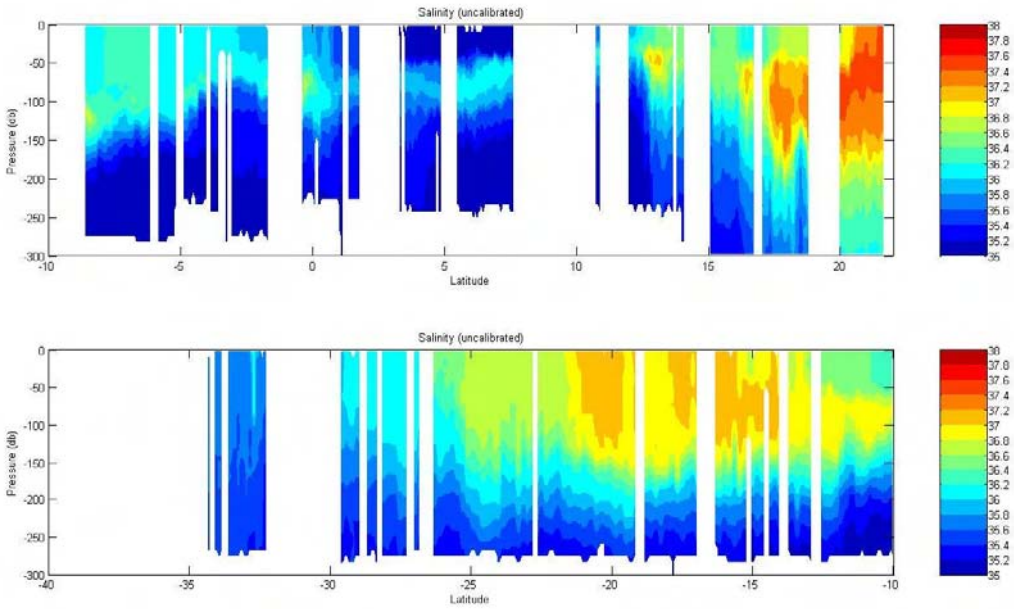

Figure 5: Uncalibrated salinity section for MVP tows 3-22.

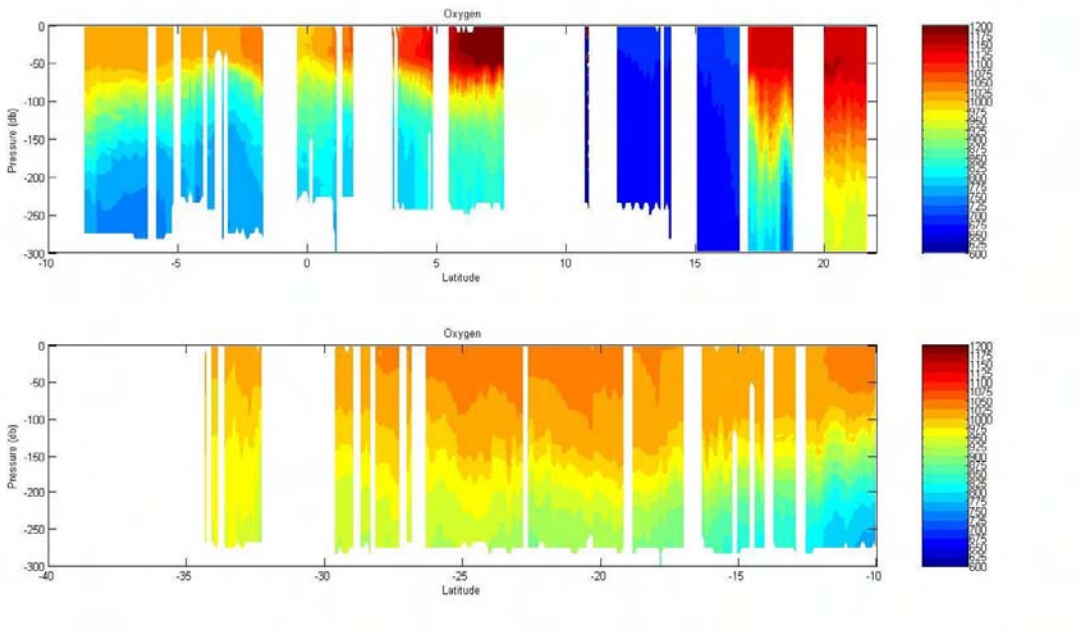

Figure 6: Oxygen section for MVP tows 3-22 (units in millivolts – calibration to be determined). Note that on tows 5, 6 and 7 the oxygen sensor failed preventing data collection (shown as completely blue sections above).

Lowered CTD Sampling, Processing and Calibration

Jo Hopkins, Stuart Painter

Introduction

In total 102 CTD profiles were completed on cruise JR218. Of these, four were full depth profiles to 4664db, 4621db, 5260db and 4694db in the Northern and Southern Gyres. Two casts were carried out to a depth of 2000m in order to collect water for IAPSO standards. Four casts were also conducted in the evening.

Aside from these additions two casts were always taken pre-dawn down to 300m and 500m respectively. The third CTD of the day was at solar noon to a depth of 500m. The locations of all CTD casts are marked in Figure 1. The cast number corresponding to the first cast of each day is labelled. Table 1 details precise cast locations and times.

Samples were taken from all CTDs in the following order: gases, trace nutrients, DOC, oxygen, salinity, pico/nano phytoplankton... everything else. Each CTD was sampled at 0.1%, 1%, 3%, 7%, 14%, 33%, 55% and 97% optical attenuation. Samples were also taken from 300m for nutirents and DOC. These depths were determined from either satellite images of Kd (attenuation coefficient) provided by Plymouth Marine Laboratory or from the previous days FRRF measurements.

Cast No	Date	Jday	Time	Latitude	Longitude
1	04/10/08	278	13:34:09	50.4027	-1.5062
2	06/10/08	280	04:59:35	49.4824	-9.8475
3	06/10/08	280	06:20:36	49.4828	-9.8471
4	06/10/08	280	13:11:30	49.3646	-11.5183
5	07/10/08	281	04:29:57	49.1492	-14.6524
6	07/10/08	281	06:01:37	49.4093	-14.6523
7	07/10/08	281	12:52:47	48.8673	-16.1938
8	08/10/08	282	04:32:03	46.5907	-18.6966
9	08/10/08	282	05:57:11	46.5907	-18.6967
10	08/10/08	282	12:14:14	45.6643	-19.5870
11	09/10/08	283	05:25:43	42.6730	-22.1949
12	09/10/08	283	06:43:12	42.6730	-22.1950
13	10/10/08	284	05:22:52	38.8820	-25.3243
14	10/10/08	284	06:52:49	38.8820	-25.3243
15	11/10/08	285	05:29:54	36.0117	-27.7373
16	11/10/08	285	06:55:08	36.0117	-27.7373
17	11/10/08	285	13:43:35	35.3138	-28.4663
18	12/10/08	286	05:27:13	33.2979	-30.7968
19	12/10/08	286	06:47:11	33.2979	-30.7968
20	12/10/08	286	13:45:41	32.4900	-31.7102
21	13/10/08	287	05:24:58	30.4724	-33.4724
22	13/10/08	287	06:47:37	30.4724	-33.9513
23	13/10/08	287	13:36:52	29.6697	-34.8335
24	14/10/08	288	15:09:39	27.6317	-37.0306
25	14/10/08	288	06:42:00	27.6316	-37.0306
26	14/10/08	288	13:36:52	26.8133	-37.8955
27	15/10/08	289	05:26:04	24.7443	-40.0885
28	15/10/08	289	06:43:07	24.7443	-40.0885
29*	15/10/08	289	09:04:20	24.7443	-40.0885
30	15/10/08	289	14:16:34	24.7382	-40.0702
31	16/10/08	290	05:25:38	22.5997	-40.2659
32	16/10/08	290	06:44:26	22.5997	-40.2658
33	16/10/08	290	13:39:33	21.6732	-39.5964

34	17/10/08	291	05:25:39	19.7224	-38.2302
35	17/10/08	291	06:42:52	19.7224	-38.2302
36	17/10/08	291	13:37:29	18.7886	-37.5778
37	18/10/08	292	05:25:03	16.8106	-36.2068
38	18/10/08	292	06:47:48	16.8105	-36.2068
39*	18/10/08	292	08:46:15	16.8105	-36.2068
40	18/10/08	292	14:22:47	16.8105	-36.2068
41	19/10/08	293	05:24:12	14.9192	-34.9221
42	19/10/08	293	06:44:55	14.9192	-34.9221
43	19/10/08	293	13:42:00	14.0932	-34.3602
44	20/10/08	294	05:25:49	11.8205	-32.8242
45	20/10/08	294	06:54:34	11.8206	-32.8242
46	20/10/08	294	13:41:39	10.8916	-32.2064
47	21/10/08	295	05:22:20	8.6438	-30.7085
48	21/10/08	295	06:33:51	8.6438	-30.7085
49	21/10/08	295	13:38:46	7.6627	-30.0594
50	22/10/08	296	05:23:53	5.3398	-28.5213
51	22/10/08	296	06:38:27	5.3398	-28.5213
52§	22/10/08	296	08:30:35	5.3405	-28.5212
53§	22/10/08	296	10:32:26	5.3407	-28.5212
54	22/10/08	296	13:47:48	5.1390	-28.3910
55	23/10/08	297	05:20:50	2.7908	-26.8539
56	23/10/08	297	06:36:58	2.7925	-26.8547
57	23/10/08	297	13:39:04	1.8306	-26.2153
58	24/10/08	298	05:23:06	-0.5850	-24.9969
59	24/10/08	298	06:37:27	-0.5794	-24.9940
60	24/10/08	298	13:12:54	-1.6274	-24.9949
61	25/10/08	299	13:54:13	-6.0524	-24.9772
62	26/10/08	300	05:22:02	-8.8254	-24.9954
63	26/10/08	300	06:36:25	-8.8254	-24.9954
64	26/10/08	300	13:35:37	-9.9752	-24.9994
65	27/10/08	301	05:21:14	-12.8396	-24.9983
66	27/10/08	301	06:37:32	-12.8396	-24.9983
67	27/10/08	301	13:38:54	-13.9944	-24.9952
68+	27/10/08	301	20:04:10	-14.9934	-24.9944
69	28/10/08	302	05:21:48	-16.6377	-24.9939
70	28/10/08	302	06:38:09	-16.6377	-24.9939
71*	28/10/08	302	08:25:32	-16.6377	-24.9939
72	28/10/08	302	13:40:19	-16.8754	-24.9961
73+	28/10/08	302	20:01:11	-17.8596	-24.9921
74	29/10/08	303	05:20:08	-19.1237	-24.9959
75	29/10/08	303	06:37:30	-19.1237	-24.9959
76	29/10/08	303	13:40:36	-20.2833	-25.0011
77+	29/10/08	303	20:04:22	-21.1135	-25.0072
78	30/10/08	304	05:29:36	-22.7853	-25.0091
79	30/10/08	304	06:43:21	-22.7854	-25.0091
80	30/10/08	304	13:39:27	-23.9345	-24.9994
81+	30/10/08	304	20:02:17	-24.8675	-25.0034
82	31/10/08	305	05:20:51	-26.5572	-24.9979
84*	31/10/08	305	08:34:51	-26.5573	-24.9979
85	31/10/08	305	14:05:42	-26.5572	-24.9978
86	01/11/08	306	05:21:12	-28.8638	-26.0361
87	01/11/08	306	06:35:21	-28.8683	-26.0361

88	02/11/08	307	14:52:03	-32.1794	-29.8255
89	02/11/08	307	16:22:17	-32.1794	-29.8256
90	03/11/08	308	06:28:37	-33.7682	-32.0030
91	03/11/08	308	07:44:53	-33.7682	-32.0030
92	03/11/08	308	14:50:51	-34.5531	-32.9804
94	04/11/08	309	06:42:26	-36.1733	-35.0542
95	04/11/08	309	14:40:20	-36.1732	-35.0541
96	05/11/08	310	05:24:20	-37.9676	-37.4125
97	05/11/08	310	06:43:31	-37.9633	-37.4040
98	05/11/08	310	14:31:27	-38.7625	-38.4591
99	06/11/08	311	14:33:06	-41.4768	-42.1395
100	07/11/08	312	05:26:34	-43.2266	-44.6134
101	07/11/08	312	06:45:12	-43.2266	-44.6134
102	07/11/08	312	14:24:53	-43.9473	-45.6473

Table 1: CTD cast positions and times. * indicate deep casts. + are evening casts.
§ IAPSO standard sea water collection.

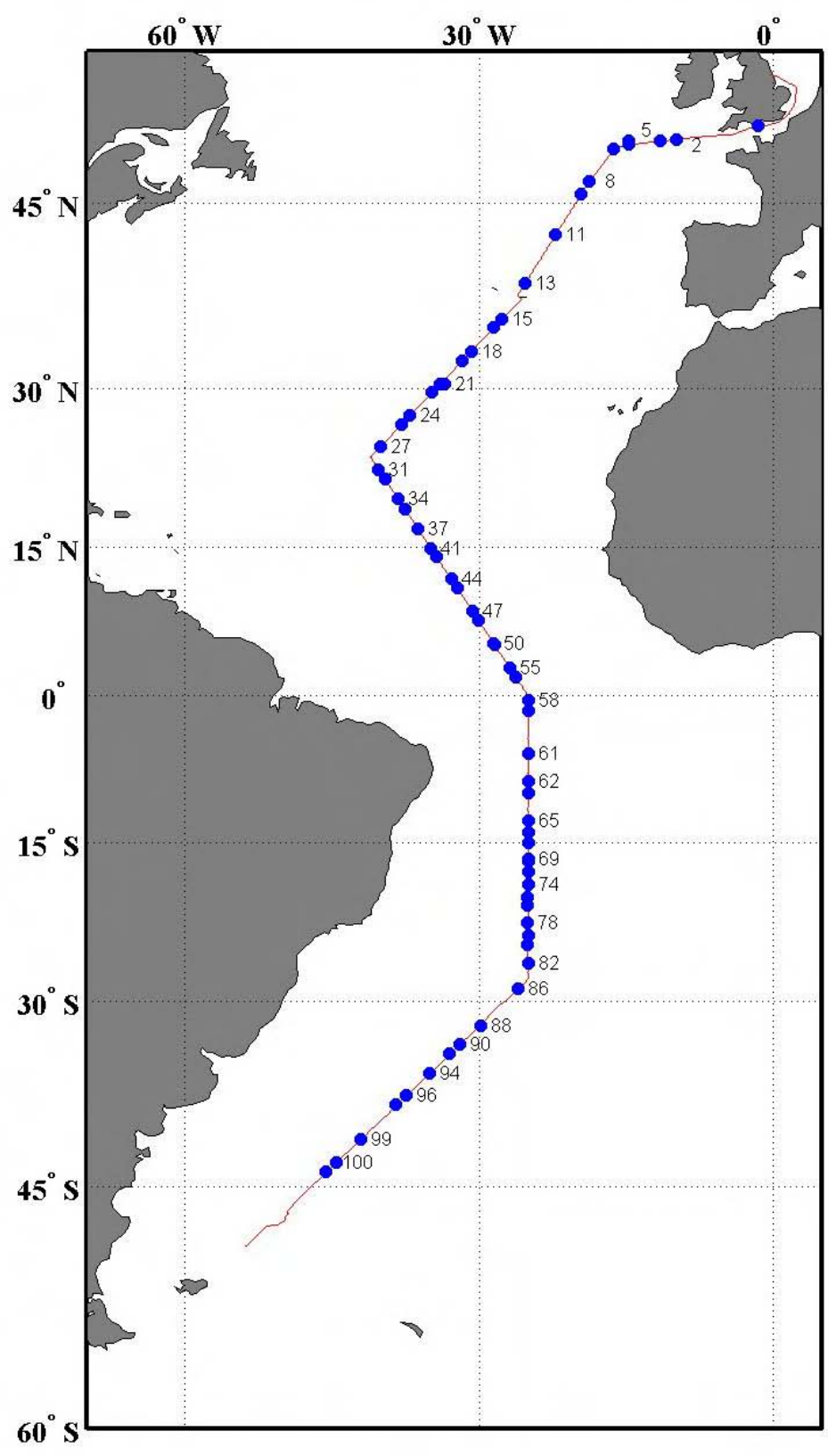

Figure 1: AMT18 cruise track. Blue dots represent the locations of each CTD cast. The first CTD of each day is marked according to its cast number.

Processing:

The processing of SeaBird CTD data closely followed that of D309 and D332.

SeaBird Software Processing (SBEDataProcessing-Win32)
CTD casts were recorded using the SeaBird data collection software Seasave-Win32 and saved locally on the CTD PC. Note that the software crashed during casts 83 and 93. These segmented files have not been processed. The software output four files in the form jr218_***nnn*** (***nnn*** = cast number) with the following extensions:

2. .dat (raw data file)
3. .CON (configuration file)
4. .BL (a record of bottle firing locations)
5. .HDR (header file)

These files were subsequently backed up onto the UNIX network at the location/data/cruise/jcr/20081001/pstar/ctd/raw. They were then processed using the SeaBird data processing software SBE Data Processing-Win32 v7.18. The following routines were applied.

DatCnv: A data conversion routine to read in the raw CTD data file (jr218_***nnn***.dat) containing data in engineering units output by the CTD hardware. Calibrations as appropriate through the instrument configuration file (jr218_***nnn***.CON) are applied.

Data Setup options were set to the following:

Process scans to end of file: yes
Scans to skip over: 0
Output format: binary
Convert data from: upcast and downcast
Create file types: both bottle and data
Source of scan range data: bottle log .BL file
Scan range offset: 0 sec
Scan range duration: 0.001 sec (based on D332 procedure)
Merge separate header file: no

Selected output variables were:

4. Time elapsed (secs)
5. Pressure, digiquartz (db)
6. Primary temperature, secondary temperature and temperature difference (°C)
7. Primary conductivity, secondary conductivity and conductivity difference (mS/cm)
8. Beam attenuation (1/m) and transmission (%)
9. Fluorescence (ug/l)
10. Oxygen voltage SBE43 (volts)
11. Oxygen saturation (%)
12. Oxygen concentration (ml/l)
13. PAR/irradiance (%)
14. Primary and secondary salinity (psu)
15. Density (kg/m^3)

The routine generates two output files: jr218_***nnn***.cnv, a binary file including both the 24hz up and downcasts; and, jr218_***nnn***.ros, a bottle file containing information from the instant that each bottle was fired.

Both files were saved to the /data/cruise/jrc/20081001/work/ctd_processed directory.

AlignCTD: This program reads in the jr218_***nnn***.cnv file and shifts the oxygen sensor relative to the pressure by 5 seconds. This compensates for lags in the sensor response times. Output is written over the input.

WildEdit: A program to remove pressure spikes. The data in jr218_***nnn***.cnv is scanned twice and the standard deviation of a set number of scans is calculated. Values outside a set number of standard deviations (sd) of the mean are marked as bad.

The following settings were used:

Scan range: 500 scans
Standard deviation for pass 1: 2 sd ŝ
Standard deviation for pass 2: 10 sd ŝ
Exclude scans marked as bad: yes

jr218_***nnn***.cnv is again overwritten.

CellTM: The Cell Thermal Mass program removes the effect of thermal ĩnertia ' on the conductivity cells. The temperature variable is used to adjust the conductivity vales. If spikes in the former exit they are amplified in the latter. The thermal anomaly amplitude α was set to 0.03 and the thermal anomaly time constant 1/β to 1/7.

Output is written over the input jr218_***nnn***.cnv.

Translate: jr218_***nnn***.cnv is converted form binary to ascii so that it can be read into pstar format.

The .cnv and .ros files were transferred across the network from /data/cruise/jrc/20081001/work/ctd_processed

to /data/cruise/jrc/20081001/pstar/ctd/processed where data processing could be continued using PEXEC routines.

PSTAR Processing
The following PSTAR execs were used to process the data.

ctd0: This script reads in the 24hz SeaBird ascii file jr218_***nnn***.cnv and converts it into PSTAR format. It requires the latitude and longitude at the bottom of each cast as recorded on the ctd log sheets. The output file is ctd218***nnn***.24hz.

ctd1: Using the PSTAR 24hz file ctd1 calls ***pmdian*** to remove residual spikes from all variables. Data are then averaged into a 1hz file (ctd218***nnn***.1hz) using ***pavrge.*** Absent data values in pressure are interpolated across using ***pintrp***. Salinity, potential temperature, sigma0 and sigma2 (referenced to 2000db) are then calculated using ***peos83***. Lastly a 10 second average file (ctd218***nnn***.10s) is created using ***pavrge***.

mlist was used inbetween execs ctd1 and ctd2 to identify from the .1hz file the cycle numbers for a. the shallowest depth of the CTD after the initial soaking (start of downcast), b. the greatest depth (end of downcast), and c. the last reliable measurements before the CTD left the water.

cd2: This program uses the cycle numbers identified from ***mlist*** to extract data from the 1hz file corresponding to i. the full up and downcast (ctd218***nnn***.ctu) and, ii. solely the downcast. The downcast is then averaged into two decibar (2db) pressure bins creating a ctd218***nnn***.2db file.

The time is then stripped from the .1hz file using ***pcopya*** and merged on time with the bestnav data stream (abnv2181). The latitude and longitude are then added into the header information of the .24hz, .1hz, .10s, .2db and .ctu files.

Files were created to compare CTD and bottle sample values for calibration of the CTD sensors using the following two scripts:

fir0: Firstly, this script converts the ctd218***nnn***.ros file produced at the SeaBird processing stage into PSTAR format. It then takes the relevant data cycles form the .10s averaged file and pastes it into a new file fir218***nnn*** containing the mean values of all the variables at the bottle firing locations.

samfir: This script creates the file sam218***nnn*** which contains selected variables from fir218***nnn*** so that results from the bottle sampling analysis can be added.

Once salinity bottle data has been processed and text files sal218***nnn***.txt created containing bottle number, cast number and bottle salinities the following two routines are run. See the ***Salinity Bottle Sample*** section for further details on salinometry measurements.

sal0: Reads in the .txt files and outputs the equivalent PSTAR format files sal218***nnn***.bot.

passal: This routine pastes bottle file (sal218***nnn***.bot) values into sam218***nnn*** files. This file also has space for other variables (e.g. oxygen, nutrients, chlorophyll) for which samples were taken.

Salinity Calibration
Each sam218***nnn*** file was passed through the exec ***botcondjr218.***

botcondjr218: The routine firstly runs ***peos83*** to calculate the conductivity for bottle salinities using both the primary and secondary CTD temperature sensors. The conductivity and salinity differences are then calculated using ***parith***. All these new variables are then added to those in sam218***nnn*** and output as new sam218***nnn***.ccal files.

Note that ***botcondjr218*** is applied as part of the batch processing script ***botcondrun.csh***. The new version codes are printed sequentially to the screen.

botcondrun.csh: Firstly, each cast is run through ***botcondjr218***. All sam218***nnn***.ccal files are then appended into a master file BOTCOND.MASTER. Note that ***papend*** calls the file ***botcondlist*** that contains a list of all .ccal files to be included. All the channels necessary to calculate the calibration coefficients are then printed to an ascii file BOTCOND.MASTER.ascii.

Seabird claim that the correct in-situ calibration for their conductivity sensors is a linear function of conductivity, with no offset. The MATLAB script ***botcond_analysis.m*** was used to a. visualise the conductivity and salinity differences and b. calculate calibration coefficients A and B where:

$A = \Sigma(cond_{bot} * cond_{ctd}) / \Sigma(cond_{ctd})^2 = mean(cond_{bot} * cond_{ctd}) / mean(cond_{ctd}^2)$

$B = \Sigma(cond2_{bot} * cond2_{ctd}) / \Sigma(cond2_{ctd})^2 = mean(cond2_{bot} * cond2_{ctd}) / mean(cond2_{ctd}^2)$

$cond2_{bot}$ is the conductivity determined using the secondary CTD temperature sensor.

Figure 2 shows bottle salinities plotted against CTD salinity measurements for both the primary and secondary sensors. It confirms a linear calibration. Those points circled in red were considered to be outliers and removed from the calibration. The cluster of points around 35 psu all come from the same crate (Crate 5 Jday 282). During this particular run a leak in the peristaltic pump was fixed half way through measurements and the temperature of the laboratory was particularly variable. This resulted in a large difference between the start and end standards and therefore poor salinity calculations. All other outliers are considered to be the result of poor sampling and/or measurement practices.

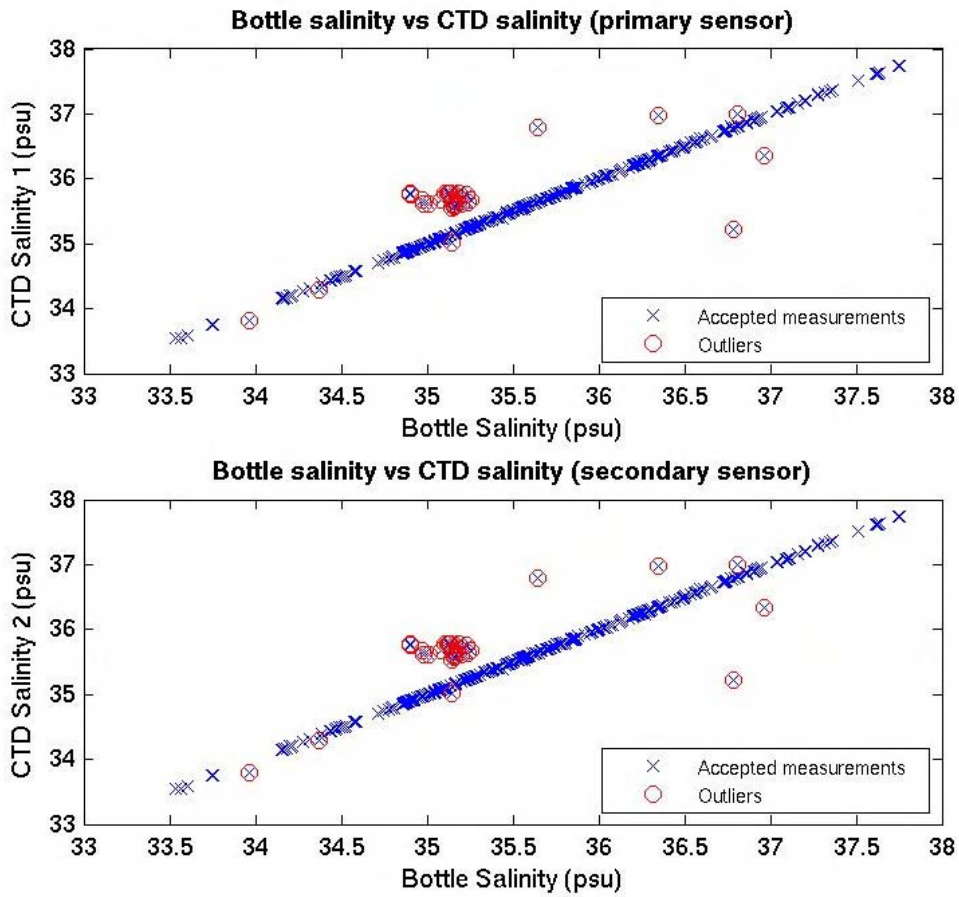

Figure 2: Bottle salinities vs CTD salinity (for both sensors). Those values circled in red have been identified as outliers and removed before calculation of the calibration coefficients.

Figure 3 shows the conductivity differences between the bottle and CTD data (outliers removed). The mean conductivity differences for the primary and secondary sensors were -0.00056 and 0.00111 respectively. The corresponding standard deviations were 0.00940 and 0.00930. This adds further strength to the expected linear calibration.

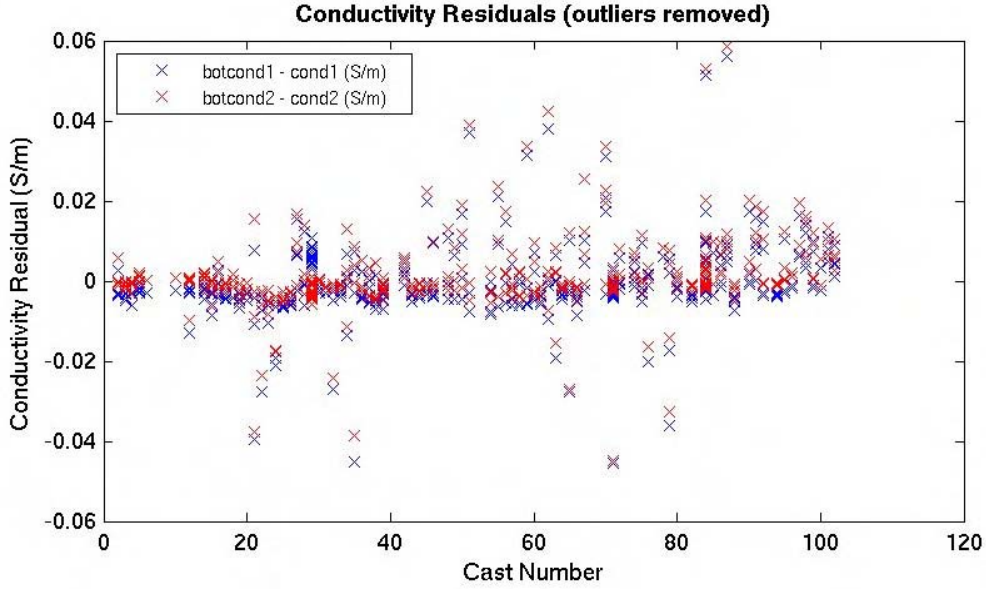

Figure 3: Conductivity differences between bottle and CTD data (outliers removed).

The coefficients A and B were calculated to be 0.9999836894 and 1.000020446 respectively.

The final calibration step was not completed while at sea. The routine ***ctdcondcal*** should be applied post cruise to calibrate the .ctu and .2db files and re-calculate salinity, potential temperature and sigma0/sigma2.

Oxygen Calibration

Calibration of the CTD's oxygen sensor was not attempted whilst onboard. However, a quick comparison with oxygen sample measurements taken on casts 49, 33 and 10 reveals a significant offset that will need to be investigated further. Figure 4 suggests that the CTD oxygen sensor is reading between 0.5 ml/l and 1 ml/l below the in-situ sample measurements.

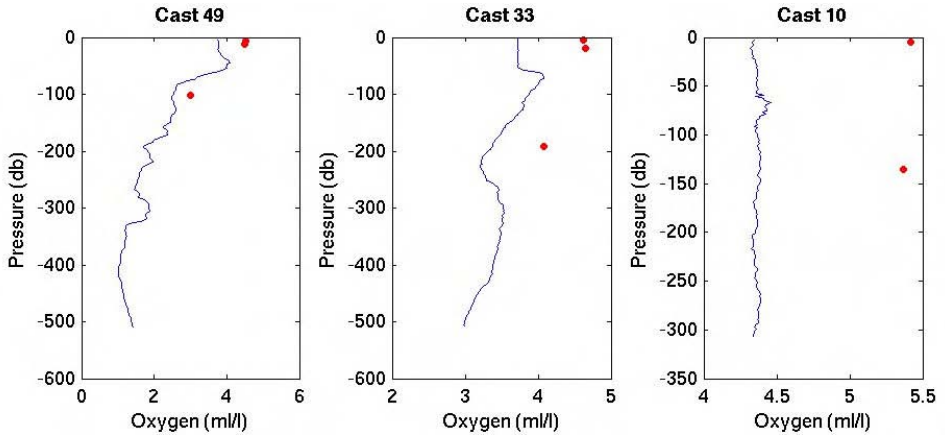

Figure 4: Oxygen profiles from casts 49, 33 and 10. Red dots mark the oxygen titration results from in-situ samples.

Preliminary Results

Figures 5 to 9 show transects of potential temperature, salinity, density, fluorescence, and oxygen. Note that these are uncalibrated values.

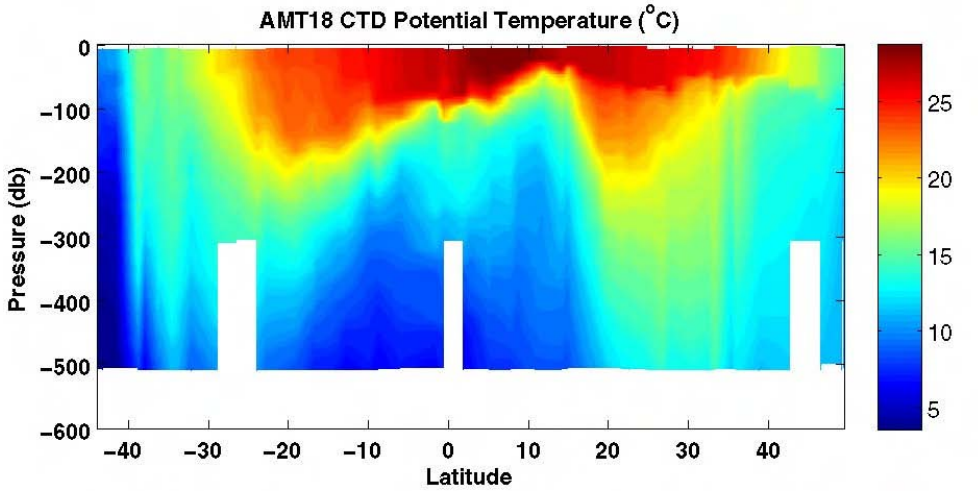

Figure 5: Potential temperature

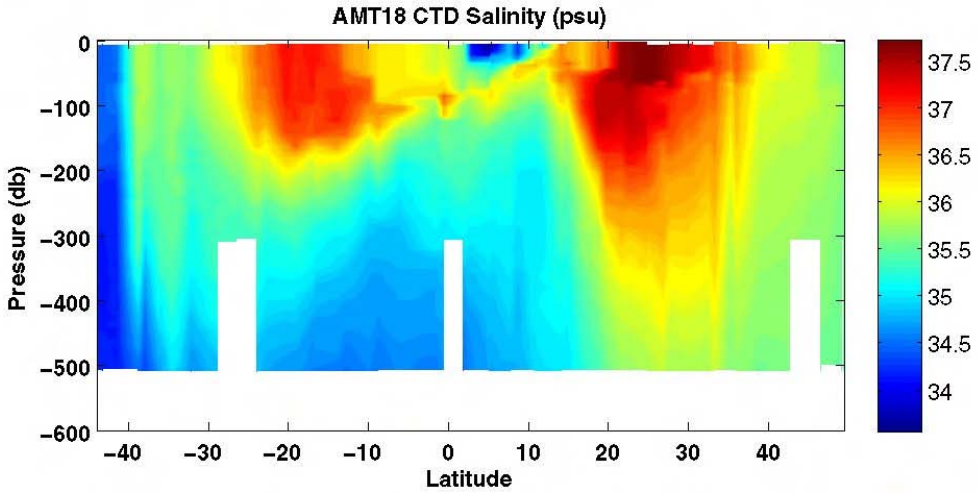

Figure 6: Salinity

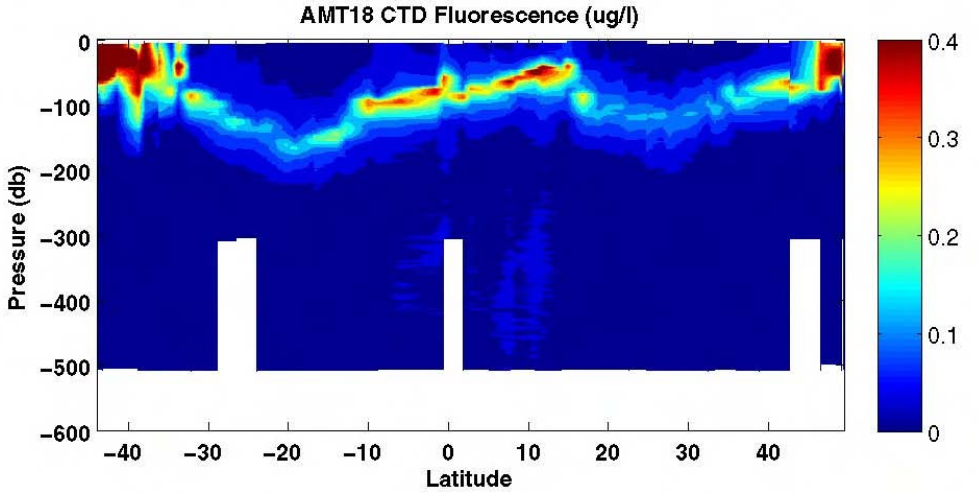

Figure 7: Fluorescence

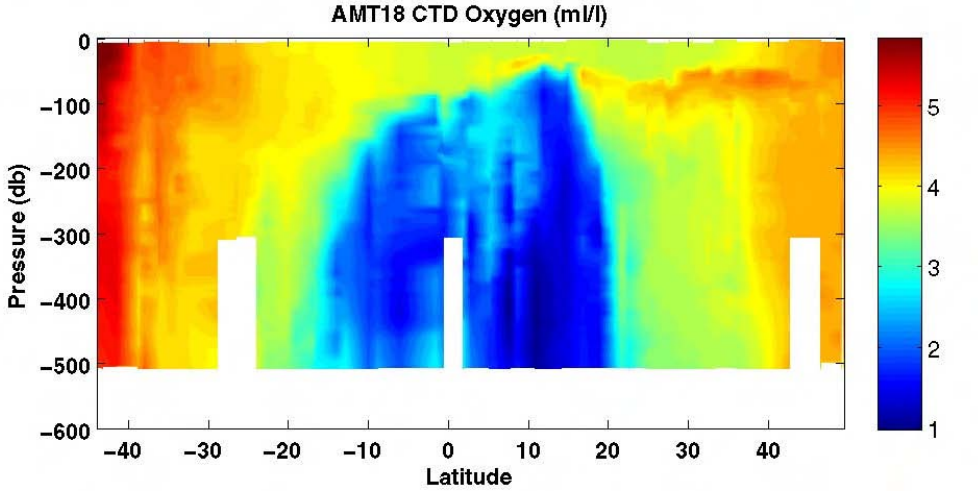

Figure 8: Oxygen

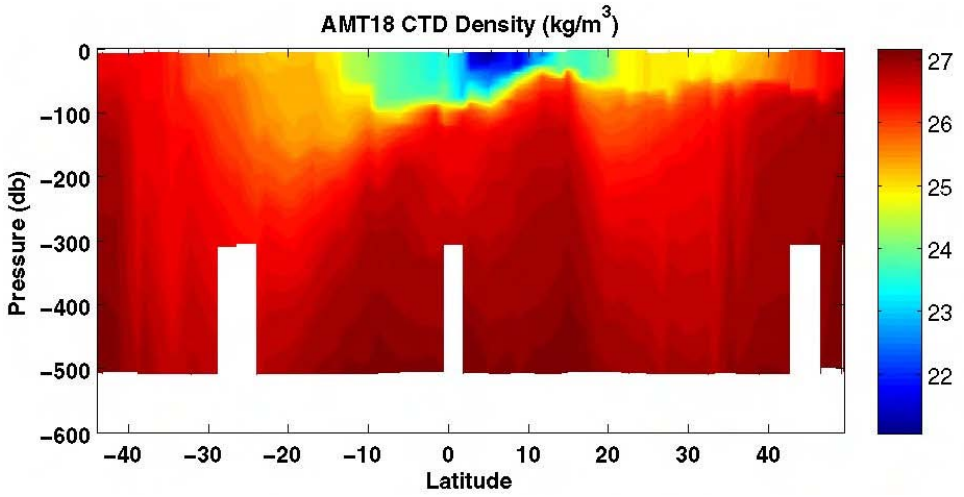

Figure 9: Density

Figure 10 is a T-S plot of all the CTD casts. Casts 1-44 are in red, 45-102 in blue. This is to highlight the shift in the profile as the front between north Atlantic and south Atlantic central water is crossed (at ~11.8°N).

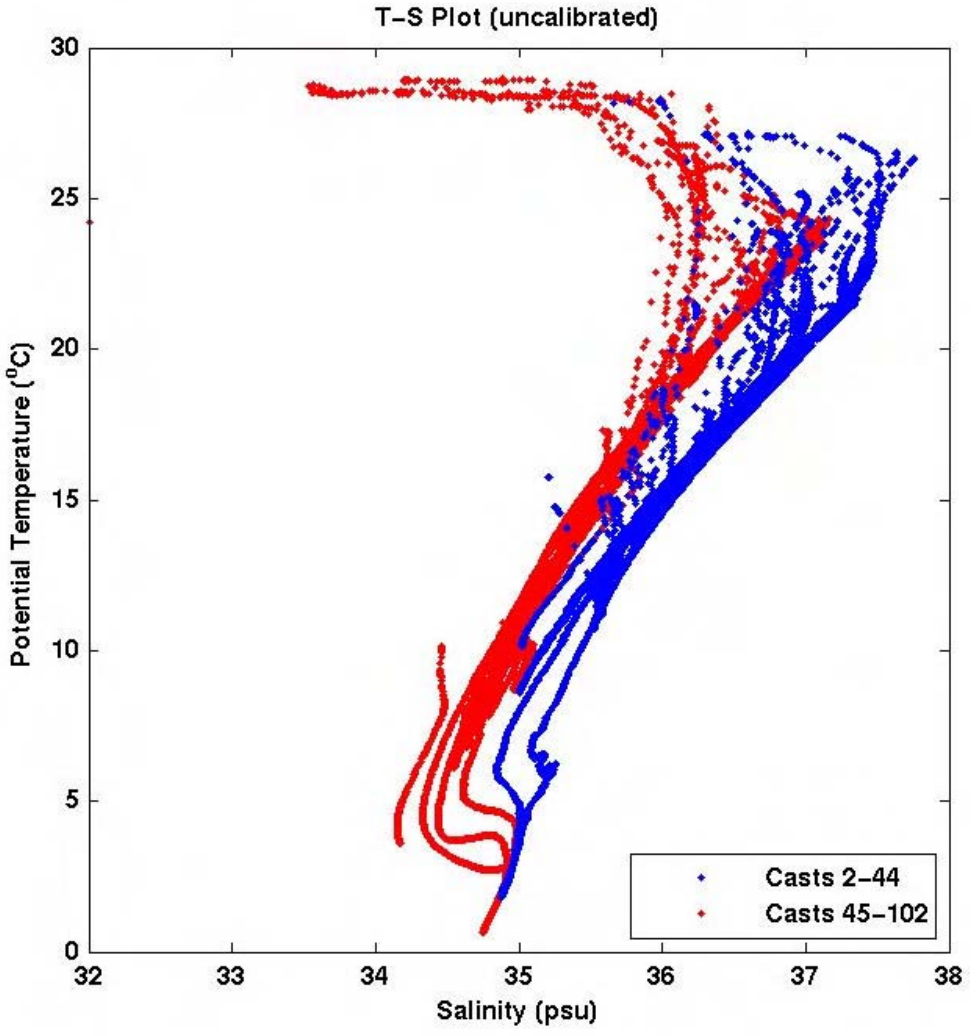

Figure 10: Temperature-Salinity plot for all CTD casts.

Salinity Bottle Samples

Jo Hopkins, Stuart Painter

On average four salinity samples were drawn from the Niskin bottles after most casts. Two samples were taken from the shallowest two depths, and two from the deepest. This was to avoid as far as possible sampling in regions of strong stratification. A greater number of samples (20-24) were taken from the deep casts. Samples were also taken from the underway supply to provide a calibration for the continual ThermoSalinoGraph (TSG) measurements and MVP profiles.

Samples were taken using 200 mL glass sample bottles that were rinsed three times in the sample water and filled to the shoulder. The inside of the bottle neck, plastic insert and bottle cap were dried and the bottle then sealed.

A Guildline 8400B Laboratory Salinometer (serial number 68959) fitted with a peristaltic pump was used to determine the salinity of all bottle samples. The instrument was situated in the Filter Preparation Lab. This location was far from ideal since the room has four adjoining doors all continually in use. As a result the temperature of the room was often highly variable.

Once a crate of sample bottles had been filled they were moved into the same room as the salinometer and left to stand for 24 hours prior to analysis. In this way the temperature of samples adjusted to the room temperature. Standardisation was performed using IAPSO Standard Seawater batch P149 before the analysis of each crate. A minimum of three readings was taken for each sample.

Following measurement all results were read into excel files Scalib_Crate***X***_J***xxx***.xls where ***X*** is the crate number and ***xxx*** the Julian day that the crate was analysed on. Averages of the g-ratios were then copied into Scal_Crate***X***_J***xxx***.xls where final salinities were calculated using a standard UNESCO formula. For underway samples a text file (uw_salinity.txt) of sample numbers, dates, times and salinities was created and appended to as each underway crate was analysed. For CTD samples bottle numbers and salinities were copied into individual cast .txt files (used by the PSTAR exec ***sal0***).

Ocean Logger Data

Jo Hopkins, Stuart Painter

Instruments

Underway surface meteorology and thermosalinograph measurements were recorded by the RVS Surfmet system throughout the ***James Clark Ross*** cruise 218 (AMT18). The parameters measured and recorded are as follows:

Non-toxic supply

Salinity sample temperature (saltemp)
Fluorometer sample temperature (fstemp)
Conductivity (cond)
Salinity (sal)
Sound velocity (velocity)
Fluorescence (fluor)
Flow rate (flow)
Sea surface temperature /Intake water temperature (sst)

Meteorology (two sensors for each variable)

Air temperature (atemp1, atemp2)
Humidity (hum1, hum2)
Photosynthetically Active Radiation (par1, par2)
Total Incident Radiation (tir1, tir2)
Barometric pressure (press1, press2)

Processing
Processing of the underway data was completed daily. The following two PSTAR routines were run.

oceanlog0: This exec converts underway surfmet data from RVS format into a PSTAR format using ***datapup***. It requires the start and stop times of the file to be input by the user. It produces a file olg218***nn***.raw where ***nn*** is the 2 digit daily file number.

oceanlog1: Firstly this routine sets unrealistic values of variables to absent using ***pedita***. Conductivity is then converted into mS/cm. Lastly, time, latitude, longitude and distance run are merged into the file from the Bestnav navigation (abnv2181). A new file olg218***nn*** is created ***c***ontaining all of the variables listed above plus the navigation data.

Salinity samples were taken from the underway source during the cruise with which to calibrate the underway salinity measurements. The necessary calibrations and removal of bad data points are to be carried out post cruise. Note that throughout the cruise the flow rate of the underway system did not remain stable introducing noise and poor readings into the data stream.

AMT18 CTD Processing – Post cruise addendum

Stuart Painter, Jo Hopkins

This document summarises the post cruise reanalysis of the AMT18 CTD data that was necessitated by the realisation that incorrect instrument calibration certificates had been supplied with two instruments (oxygen and temperature sensors). For various reasons a quick fix could not be applied to the data and a full reprocessing of the data was required. Further details of the CTD conductivity calibration, which was not performed at sea, are also included below. The information contained herein supports and/or replaces the information detailed in the AMT18 cruise report.

Reprocessing differences
During an internal audit of instrument calibration certificates conducted by Richard Bridgeman at BAS it was discovered that some of the certificates supplied for AMT18 were incorrect. Specifically the calibration certificates for the Seabird 43 (SBE43) dissolved oxygen sensor and the Seabird 35 (SBE35) thermometer were out of date. Fortunately, because the SBE35 calibration coefficients are loaded internally from the instrument the collected data was not incorrect, only the paperwork was. There was therefore no impact upon the collected data. In the case of dissolved oxygen measurements however the calibration coefficients are manually loaded and originally came from the supplied paperwork. As there appeared to be a significant difference in the coefficient of the calibration it was likely that significant errors existed within the data.

An initial investigation trying to salvage some of the work done during the cruise could not fully replicate all stages of the calibration (specifically the time acceleration step). There was no alternative therefore other than to fully reprocess the data starting with the Seabird processing stages and then moving on to the higher PSTAR processing stages as documented in the AMT18 cruise report.

All processing stages were reproduced as documented in the AMT18 cruise report with only two minor changes. Firstly, SBE43 calibration coefficients were identified within the .CON files produced during the CTD acquisition stage and manually edited to update them to the correct values. All Seabird processing was then completed as previously documented. Secondly, all PSTAR processing was replicated as before but a minor change to include the PAR data output was instigated under processing exec CTD1.

Conductivity calibration
Following the production of bottle sampling files the conductivity calibration obtained on the cruise was checked. A more stringent assessment of the data was performed (Figure 1) and coefficients A and B were subsequently modified from their previously documented values.

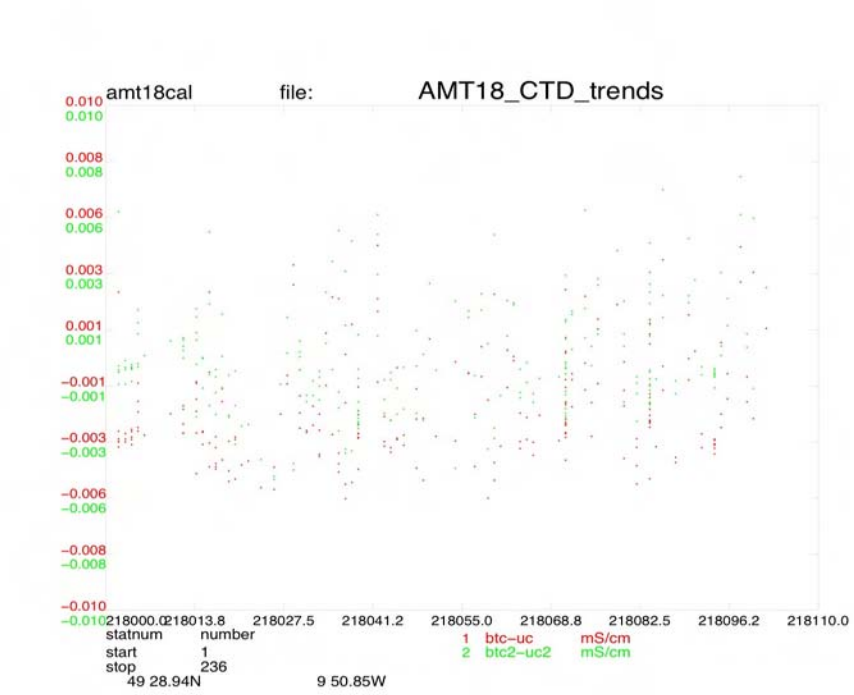

Figure 1: Conductivity residuals

Coefficients A and B were calculated from the following equations using the data in Figure 1.

$$conductivity = A * (primary\ conductivity)$$

$$conductivity = B * (secondary\ conductivity)$$

where

$$A = \frac{\sum Cond_{bot} Cond_{ctd}}{\sum (Cond_{ctd})^2} = \frac{\overline{Cond_{bot} Cond_{ctd}}}{\overline{(Cond_{ctd})^2}}$$

and

$$B = \frac{\sum Cond2_{bot} Cond2_{ctd}}{\sum (Cond2_{ctd})^2} = \frac{\overline{Cond2_{bot} Cond2_{ctd}}}{\overline{(Cond2_{ctd})^2}}$$

A = 0.99995523 (previously 0.999983689, difference = 0.0000285)

B = 0.99999757 (previously 1.000020446, difference = 0.0000229)

In the case of conductivity the mean difference on channel 1 between the bottle (salinometry) conductivity and the CTD conductivity was 0.000032 (stdev 0.002). On channel 2 it was 0.000078 (stdev 0.002).

Salinity mean differences were 0.000034 psu and 0.000097 psu on channel 1 and channel 2 respectively.

Having obtained new values of A and B, conductivity was recalculated for each CTD cast by multiplying the measured conductivity value by either A or B (channel 1 and channel 2 respectively) and thereafter salinity was recalculated. Potential temperature and density were also recalculated to take into account the changes in salinity.

Changes to oxygen concentrations

The application of the correct SBE43 calibration coefficients has had varying impacts upon the vertical profiles of dissolved oxygen. Figure 2 shows selected profiles that reveal general reductions in the revised oxygen concentrations relative to the original estimates. Significant

differences continue to exist between measured concentrations (titrations) and SBE43 concentrations but hopefully this can be easily remedied during the calibration process. In general terms the difference that results from the change in the SBE43 calibration coefficients is up to 0.35 ml/l (Figure 3).

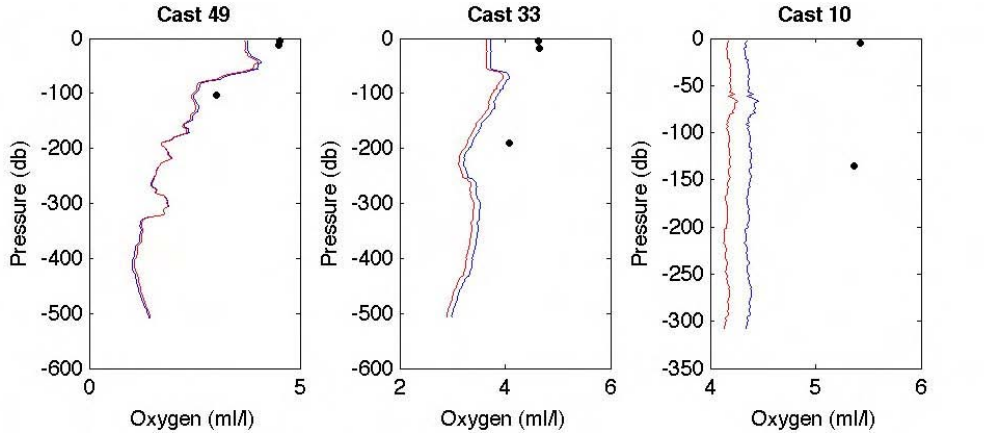

Figure 2: Comparison of original (blue) and revised (red) calibration coefficients on oxygen concentration. Shown for comparison are selected bottle oxygen measurements (filled circles) clearly revealing a further calibration exercise is needed.

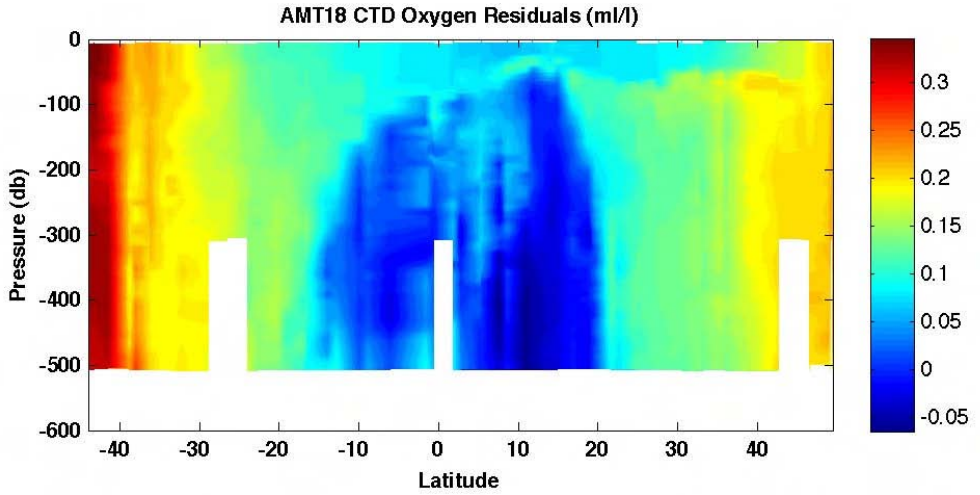

Figure 3: Magnitude of the change in dissolved oxygen concentration resulting from the change in calibration coefficients. Calculated as original oxygen concentration – revised oxygen concentration

Updated contour sections

Following the application of the conductivity calibration potential temperature, salinity and density were recalculated (Figures 4,5,6). A revised oxygen section was also produced to examine the impact the change in calibration had (Figure 7) but it has not yet been possible to calibrate the oxygen data. Further work is required to calibrate the fluorescence data as well (Figure 8).

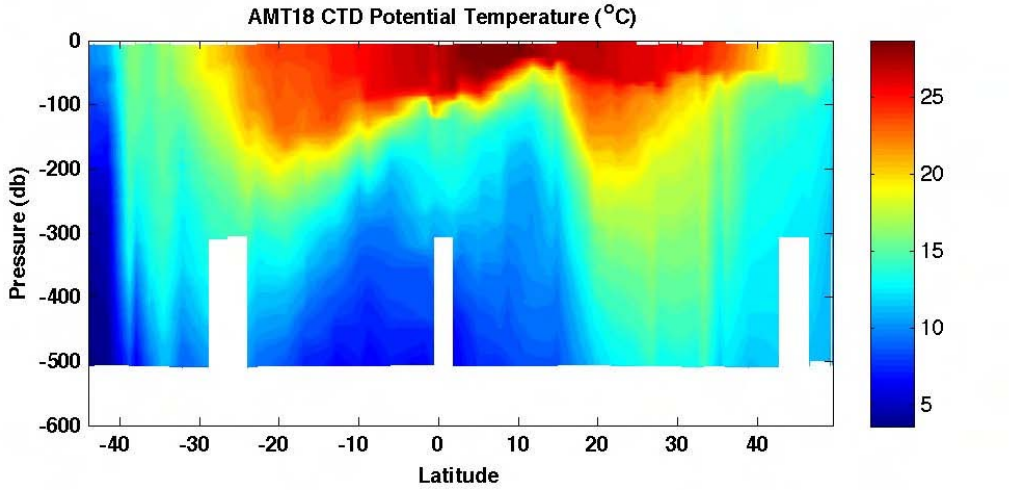

Figure 4: Calibrated potential temperature section

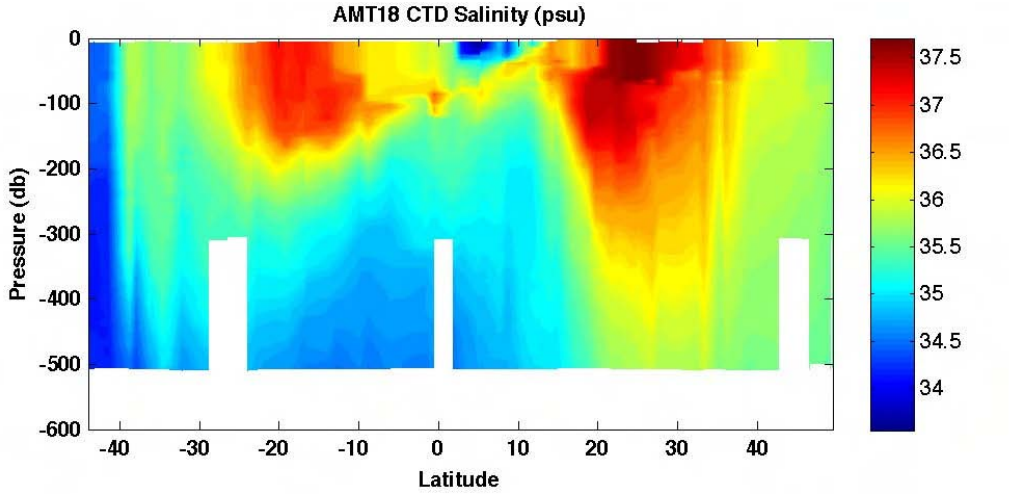

Figure 5: Calibrated salinity section

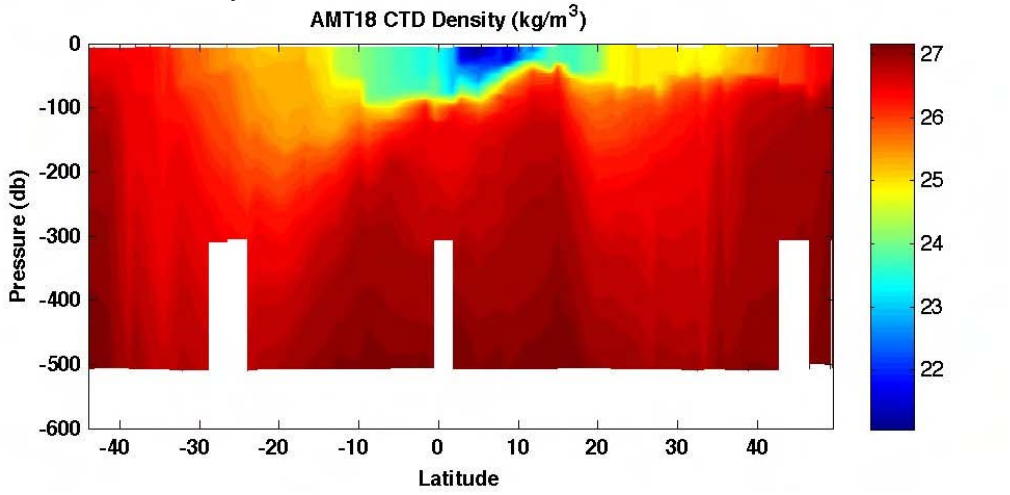

Figure 6: Calibrated density (sigma□) section

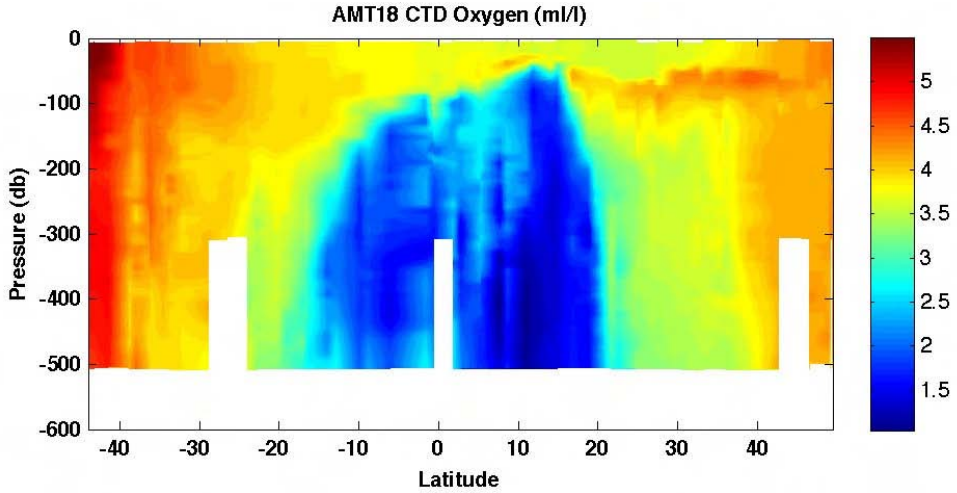

Figure 7: Corrected dissolved oxygen (UNCALIBRTAED)

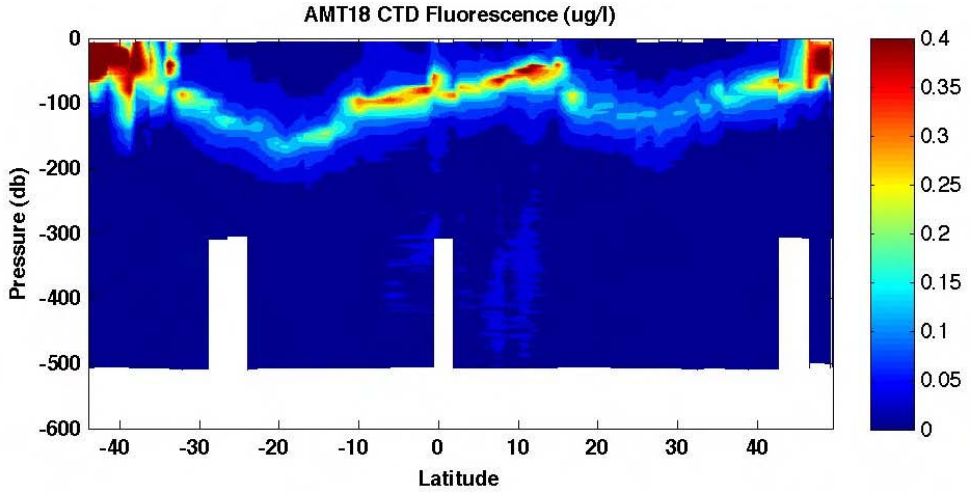

Figure 8: Fluorescence section (UNCALIBRATED)

AMT 18 Bio-Optics and remote sensing

RRS James Clark Ross, 4-October – 8 November 2008

Bruce C. Bowler
Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, ME 04575 USA

Cruise Objectives

1. Collection of Niskin samples from 6-8 depths at pre-dawn and noon stations as well as underway (approximately every 3-6 hrs) surface samples for analysis of particulate inorganic carbon (PIC), particulate organic carbon (POC), coccolith enumeration using birefringence microscopy and biogenic silica concentration (BSi). The purpose of these samples was to provide an assessment of the inorganic and organic particles in surface water, along with indices of community composition. These data are to be used for algorithm development for NASA MODIS ocean color sensors (see below).

2. Operation of an along-track flow-through system from the ship's non-toxic seawater system to characterize the hydrographic and bio-optical properties of the water.

3.Water-leaving radiance measurements in the visible wavelengths taken from the bow of the ship, for characterizing the particulate content of the seawater, and comparison to NASA's SeaWiFS and MODIS ocean color satellite products.

Methods

Particulate Inorganic Carbon: A 200 ml sample of seawater was taken from between 6-8 depths and was vacuum filtered onto 0.45µm polycarbonate filters. The filters were rinsed with potassium tetraborate buffer and stored in centrifuge tubes at room temperature.

Coccolithophore composition (Light microscopy): Microscope enumeration of coccolithophores and coccoliths was done by filtering a 200ml water sample through a Millipore HA filter, rinsed with borate buffer, and frozen in a petri dish until counted (Haidar and Thierstein 2001; Haidar et al. 2000). Back in the laboratory, the filter will be placed on a glass microscope slide, and 60^{o}C Canada Balsam placed on top of the filter, followed by a cover slip. The clarified filter will be examined with an Olympus BH2 microscope equipped with polarization optics. Birefringent coccoliths and plated coccolithophores will then be counted.

Biogenic Silica (BSi): A 200 ml sample of seawater was taken for the analysis of BSi from 6-8 sampling depths. The sample was vacuum-filtered onto 47mm 0.□□□m polycarbonate filters.

Particulate Organic Carbon: A 1000-2400ml sample of seawater was taken from between 6-8 depths and was vacuum filtered onto 0.7 µm pre-combusted GF/F filters. The filters were placed in a petri dish and frozen until analysis.

Flow-through bio-optical system

This system operates semi-continuously with water from the ships non-toxic supply. Every 6-10 minutes it measures temperature, salinity, chlorophyll fluorescence, total backscattering at 532nm (bb_{tot}), acidified backscattering (bb_{acid}; backscattering of the seawater suspension after the pH has been lowered to dissolve calcium carbonate), acid labile backscattering (bb'; the difference between the bb_{tot} and bb_{acid}), absorption and attenuation at 9 visible wavelengths (made every 2 minutes), absorption and attenuation at 9 visible wavelengths after water was routed through 0.2um filters (during intervening 2 minute segments).

Above-Water Radiance Measurements

In order to check the PIC algorithm performance, free of atmospheric error, water-leaving radiance, sky radiance and downwelling irradiance were measured from the bow of the ***RRS James Clark Ross*** using a Satlantic SeaWiFS Aircraft Simulator (MicroSAS). Key wavelengths used in the 2-band and 3-band calcite algorithms were measured with the MicroSAS. The system consists of a down-looking radiance sensor and a sky-viewing radiance sensor, both mounted on the bow. A downwelling irradiance sensor was mounted

far from any potentially shading structures, on the tallest mast of the ***RRS James Clark Ross***. These data were then used to estimate normalized water-leaving radiance as a function of wavelength. The radiance detector was set to view the water at 40^{o} from nadir as recommended by Mueller et al. (2003b). Sensors were rinsed regularly with Milli-Q water in order to remove salt deposits and any dust. The water radiance sensor was able to view over an azimuth range of ~180^{o} across the ship's heading with no contamination from the ship's 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 constantly calculated the sun's azimuth angle relative to the ship's heading. The system used the ships gyro-compass to determine the heading of the ship. Pitch and roll sensors provided a means to filter out any measurements made from sub-optimal viewing geometries due to ship's motion. Depending on the ship's course, the computer controlled a stepping 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). Before 1000h and after 1400h local time, data quality was poorer as the solar elevation decreased. Post-cruise, the 10Hz data will be filtered to remove as much residual white cap and glint as possible (we accept the lowest 5% of the data). When the ship was stopped on station, measurements were also made. A plaque calibration was performed every several days (using a 2% spectralon plaque) to check for instrument drift.

Measurement details

Water-column sampling during AMT18 concentrated around collection of the main core measurements from 6 light depths from the predawn CTD cast (~0300 – 0430h local time). PIC, POC, BSi and cell count measurements were made on 8 depths from the morning cast, typically to 300m depth. The same measurements were made from a reduced set of depths from the late morning optics 'cast (1300h local time).

(a) Underway

date	time gmt	Calendar Day	CTD# or UW identifier	Decimal Latitude	Decimal Longitude	Sample #	CHN?	PIC?	CC?	BiSi?
10/4/2008	18:03	278	AA	50.2037	-2.4631	1	y	y	y	y
10/5/2008	10:00	279	AB	49.7727	-4.7685	2	y	y	y	y
10/5/2008	14:02	279	AC	49.7329	-5.7966	3	y	y	y	y
10/5/2008	17:53	279	AD	49.6909	-6.9044	4	y	y	y	y
10/6/2008	9:25	280	AE	49.4333	-10.5000	13	y	y	y	y
10/6/2008	19:01	280	AF	49.3260	-11.9930	20	y	y	y	y
10/7/2008	9:48	281	AG	49.0170	-15.4450	29	y	y	y	y
10/7/2008	17:12	281	AH	48.3806	-16.7191	36	y	y	y	y
10/7/2008	20:16	281	AI	47.8770	-17.2710	37	y	y	y	y
10/8/2008	9:56	282	AJ	46.1366	-19.1544	46	y	y	y	y
10/8/2008	16:16	282	AK	45.1789	-20.0210	53	y	y	y	y
10/8/2008	21:05	282	AL	44.2650	-20.8180	54	y	y	y	y
10/9/2008	11:15	283	AM	41.9640	-22.7880	63	y	y	y	y
10/9/2008	15:24	283	AN	41.1470	-23.4710	64	y	y	y	y
10/9/2008	20:17	283	AO	40.2570	-24.2100	65	y	y	y	y
10/10/2008	10:23	284	AP	38.4720	-25.6500	74	y	y	y	y
10/10/2008	13:37	284	AQ	37.9640	-25.9800	75	y	y	y	y
10/10/2008	20:23	284	AR	37.1850	-26.2850	76	y	y	y	y
10/11/2008	11:06	285	AS	35.6100	-28.1680	85	y	y	y	y
10/11/2008	17:53	285	AT	34.8680	-28.9950	92	y	y	y	y
10/11/2008	22:22	285	AU	34.2420	-29.7230	93	y	y	y	y
10/12/2008	10:05	286	AV	32.9550	-31.1880	102	y	y	y	y
10/12/2008	17:47	286	AW	32.0480	-32.2090	109	y	y	y	y
10/12/2008	21:39	286	AX	31.5040	-32.8140	110	y	y	y	y
10/13/2008	10:20	287	AY	30.0930	-34.3750	119	y	y	y	y

10/13/2008	17:18	287	AZ	29.3070	-35.2330	126	y	y	y	y
10/13/2008	20:47	287	BA	28.8110	-35.7650	127	y	y	y	y
10/14/2008	10:17	288	BB	27.2500	-37.4400	136	y	y	y	y
10/14/2008	18:04	288	BC	26.3230	-38.4260	143	y	y	y	y
10/14/2008	21:15	288	BD	25.8670	-38.9060	144	y	y	y	y
10/15/2008	17:44	289	BE	24.3930	-40.4580	163	y	y	y	y
10/15/2008	21:00	289	BF	23.9280	-40.9330	164	y	y	y	y
10/16/2008	10:25	290	BG	22.1500	-39.9440	173	y	y	y	y
10/16/2008	17:53	290	BH	21.2520	-39.3100	180	y	y	y	y
10/16/2008	21:34	290	BI	20.7550	-38.9590	181	y	y	y	y
10/17/2008	11:03	291	BJ	19.1520	-37.8370	190	y	y	y	y
10/17/2008	17:30	291	BK	18.4010	-37.3260	197	y	y	y	y
10/17/2008	20:35	291	BL	17.9700	-37.0180	198	y	y	y	y
10/18/2008	17:30	292	BM	16.5310	-36.0240	213	y	y	y	y
10/18/2008	21:57	292	BN	15.9250	-35.6120	214	y	y	y	y
10/19/2008	9:49	293	BO	14.6700	-34.7580	223	y	y	y	y
10/19/2008	17:46	293	BP	13.6550	-34.0540	230	y	y	y	y
10/19/2008	21:13	293	BQ	13.0850	-33.6850	231	y	y	y	y
10/20/2008	10:56	294	BR	11.2870	-32.4740	240	y	y	y	y
10/20/2008	18:19	294	BS	10.4150	-31.8950	247	y	y	y	y
10/20/2008	21:15	294	BT	9.9390	-31.5750	248	y	y	y	y
10/21/2008	10:10	295	BU	8.1830	-30.4080	257	y	y	y	y
10/21/2008	18:05	295	BV	7.1300	-29.7060	264	y	y	y	y
10/21/2008	21:34	295	BW	6.5560	-29.3260	265	y	y	y	y
10/22/2008	17:17	296	BX	4.7210	-28.1180	280	y	y	y	y
10/22/2008	21:28	296	BY	4.0400	-27.6660	281	y	y	y	y
10/23/2008	11:12	297	BZ	2.1900	-26.4510	290	y	y	y	y
10/23/2008	17:26	297	CA	1.3640	-25.9140	297	y	y	y	y
10/23/2008	22:06	297	CB	0.6310	-25.4300	298	y	y	y	y
10/24/2008	10:25	298	CC	-1.1460	-25.0010	307	y	y	y	y
10/24/2008	17:58	298	CD	-2.2490	-25.0000	314	y	y	y	y
10/25/2008	7:12	299	CE	-4.8480	-25.0000	315	y	y	y	y
10/25/2008	11:00	299	CF	-5.5930	-25.0010	316	y	y	y	y
10/25/2008	17:45	299	CG	-6.6200	-25.0030	323	y	y	y	y
10/25/2008	21:23	299	CH	-7.3360	-25.0000	324	y	y	y	y
10/26/2008	10:01	300	CI	-9.3360	-25.0010	333	y	y	y	y
10/26/2008	17:52	300	CJ	-10.6420	-25.0000	340	y	y	y	y
10/26/2008	21:14	300	CK	-11.3070	-25.0000	341	y	y	y	y
10/27/2008	10:40	301	CL	-13.4550	-25.0000	350	y	y	y	y
10/27/2008	17:07	301	CM	-14.4690	-24.9840	357	y	y	y	y
10/27/2008	21:00	301	CN	-15.0750	-24.9880	358	y	y	y	y
10/28/2008	18:23	302	CO	-17.5880	-25.0020	376	y	y	y	y
10/28/2008	21:39	302	CP	-18.0000	-24.9830	377	y	y	y	y
10/29/2008	10:34	303	CQ	-19.7250	-25.0000	386	y	y	y	y
10/29/2008	17:28	303	CR	-20.6620	-24.9920	393	y	y	y	y
10/29/2008	21:17	303	CS	-21.2620	-25.0030	394	y	y	y	y
10/30/2008	10:50	304	CT	-23.4300	-24.9980	403	y	y	y	y
10/30/2008	17:10	304	CU	-24.3460	-24.9980	410	y	y	y	y
10/30/2008	21:32	304	CV	-25.0870	-25.0000	411	y	y	y	y
10/31/2008	17:30	305	CW	-27.0610	-25.0040	426	y	y	y	y
10/31/2008	21:35	305	CX	-27.8260	-25.0000	427	y	y	y	y
11/1/2008	10:31	306	CY	-29.2740	-26.5070	436	y	y	y	y
11/1/2008	13:29	306	CZ	-29.6340	-26.9540	437	y	y	y	y

11/1/2008	17:17	306	DA	-29.9650	-27.3860	438	y	y	y	y
11/1/2008	21:25	306	DB	-30.3080	-27.9210	439	y	y	y	y
11/2/2008	6:57	307	DC	-31.1960	-28.9410	440	y	y	y	y
11/2/2008	11:05	307	DD	-31.7240	-29.3920	441	y	y	y	y
11/2/2008	19:15	307	DE	-32.3580	-30.1180	448	y	y	y	y
11/2/2008	22:40	307	DF	-32.7700	-30.7530	449	y	y	y	y
11/3/2008	11:09	308	DG	-34.1070	-32.4240	458	y	y	y	y
11/3/2008	21:16	308	DH	-35.1050	-33.6850	465	y	y	y	y
11/4/2008	11:02	309	DI	-36.1730	-35.0540	474	y	y	y	y
11/4/2008	18:47	309	DJ	-36.5970	-35.5970	481	y	y	y	y
11/4/2008	22:40	309	DK	-37.1190	-36.2830	482	y	y	y	y
11/5/2008	11:27	310	DL	-38.4450	-38.0270	491	y	y	y	y
11/5/2008	18:23	310	DM	-39.1290	-38.8910	498	y	y	y	y
11/5/2008	22:10	310	DN	-39.5960	-39.4940	499	y	y	y	y
11/6/2008	5:55	311	DO	-40.4820	-40.7600	500	y	y	y	y
11/6/2008	9:55	311	DP	-40.9380	-41.3440	501	y	y	y	y
11/6/2008	18:25	311	DQ	-41.8300	-42.6440	508	y	y	y	y
11/7/2008	10:52	312	DR	-43.5180	-45.0390	517	y	y	y	y
11/7/2008	17:54	312	DS	-44.2950	-46.1400	524	y	y	y	y
11/7/2008	22:28	312	DT	-44.8880	-47.0240	525	y	y	y	y
11/8/2008	7:09	313	DU	-45.8670	-48.4840	526	y	y	y	y
11/8/2008	11:12	313	DV	-46.4460	-49.1310	527	y	y	y	y

(b) CTD stations

Table 2. Stations (CTD cast number) sampled and measurement(s) made. Abbreviations used are BSi (particulate biogenic silica), PIC (particulate inorganic carbon), POC (particulate organic carbon) and CC (cell counts,coccolithophores and coccoliths). A blank indicates no sample was taken.

date	time gmt	Calendar Day	CTD#or UW identifier	Decimal Latitude	Decimal Longitude	Sample #	Depth (m)	CHN?	PIC?	CC?	BiSi?
10/6/2008	6:15	280	3	49.4827	-9.1803	5	1	y	Y	y	y
10/6/2008	6:15	280	3	49.4827	-9.1803	6	10	y	Y	y	y
10/6/2008	6:15	280	3	49.4827	-9.1803	7	25	y	Y	y	y
10/6/2008	6:15	280	3	49.4827	-9.1803	8	35	y	Y	y	y
10/6/2008	6:15	280	3	49.4827	-9.1803	9	60	y	Y	y	y
10/6/2008	6:15	280	3	49.4827	-9.1803	10	100	y	Y	y	y
10/6/2008	6:15	280	3	49.4827	-9.1803	11	120	y	Y	y	y
10/6/2008	6:15	280	3	49.4827	-9.1803	12	134	y	Y	y	y
10/6/2008	13:57	280	4	49.3718	-11.3907	14	1	y	Y	y	y
10/6/2008	13:57	280	4	49.3718	-11.3907	15	10	y	Y		y
10/6/2008	13:57	280	4	49.3718	-11.3907	16	20	y	y		y
10/6/2008	13:57	280	4	49.3718	-11.3907	17	25	y	y		y
10/6/2008	13:57	280	4	49.3718	-11.3907	18	40	y	y		y
10/6/2008	13:57	280	4	49.3718	-11.3907	19	150	y	y		y
10/7/2008	6:13	281	6	49.1492	-14.6525	21	1	y	y	y	y
10/7/2008	6:13	281	6	49.1492	-14.6525	22	6	y	y	y	y
10/7/2008	6:13	281	6	49.1492	-14.6525	23	12	y	y	y	y
10/7/2008	6:13	281	6	49.1492	-14.6525	24	21	y	y	y	y
10/7/2008	6:13	281	6	49.1492	-14.6525	25	49	y	y	y	y
10/7/2008	6:13	281	6	49.1492	-14.6525	26	73	y	y	y	y
10/7/2008	6:13	281	6	49.1492	-14.6525	27	200	y	y	y	y
10/7/2008	6:13	281	6	49.1492	-14.6525	28	300	y	y	y	y

10/7/2008	12:53	281	7	48.8687	-16.1947	30	1	y	y	y	y
10/7/2008	12:53	281	7	48.8687	-16.1947	31	6	y	y		y
10/7/2008	12:53	281	7	48.8687	-16.1947	32	12	y	y		y
10/7/2008	12:53	281	7	48.8687	-16.1947	33	21	y	y		y
10/7/2008	12:53	281	7	48.8687	-16.1947	34	49	y	y		y
10/7/2008	12:53	281	7	48.8687	-16.1947	35	73	y	y		y
10/8/2008	6:09	282	9	46.5907	-18.6967	38	1	y	y	y	y
10/8/2008	6:09	282	9	46.5907	-18.6967	39	7	y	y	y	y
10/8/2008	6:09	282	9	46.5907	-18.6967	40	13	y	y	y	y
10/8/2008	6:09	282	9	46.5907	-18.6967	41	23	y	y	y	y
10/8/2008	6:09	282	9	46.5907	-18.6967	42	54	y	y	y	y
10/8/2008	6:09	282	9	46.5907	-18.6967	43	81	y	y	y	y
10/8/2008	6:09	282	9	46.5907	-18.6967	44	200	y	y	y	y
10/8/2008	6:09	282	9	46.5907	-18.6967	45	300	y	y	y	y
10/8/2008	12:55	282	10	45.6642	-19.5870	47	1	y	y	y	y
10/8/2008	12:55	282	10	45.6642	-19.5870	48	8	y	y		y
10/8/2008	12:55	282	10	45.6642	-19.5870	49	15	y	y		y
10/8/2008	12:55	282	10	45.6642	-19.5870	50	27	y	y		y
10/8/2008	12:55	282	10	45.6642	-19.5870	51	65	y	y		y
10/8/2008	12:55	282	10	45.6642	-19.5870	52	98	y	y		y
10/9/2008	6:55	283	12	42.6729	-22.1950	55	1	y	y	y	y
10/9/2008	6:55	283	12	42.6729	-22.1950	56	12	y	y	y	y
10/9/2008	6:55	283	12	42.6729	-22.1950	57	22	y	y	y	y
10/9/2008	6:55	283	12	42.6729	-22.1950	58	40	y	y	y	y
10/9/2008	6:55	283	12	42.6729	-22.1950	59	95	y	y	y	y
10/9/2008	6:55	283	12	42.6729	-22.1950	60	143	y	y	y	y
10/9/2008	6:55	283	12	42.6729	-22.1950	61	200	y	y	y	y
10/9/2008	6:55	283	12	42.6729	-22.1950	62	300	y	y	y	y
10/10/2008	7:04	284	14	38.9821	-25.3243	66	1	y	y	y	y
10/10/2008	7:04	284	14	38.9821	-25.3243	67	13	y	y	y	y
10/10/2008	7:04	284	14	38.9821	-25.3243	68	24	y	y	y	y
10/10/2008	7:04	284	14	38.9821	-25.3243	69	43	y	y	y	y
10/10/2008	7:04	284	14	38.9821	-25.3243	70	102	y	y	y	y
10/10/2008	7:04	284	14	38.9821	-25.3243	71	153	y	y	y	y
10/10/2008	7:04	284	14	38.9821	-25.3243	72	200	y	y	y	y
10/10/2008	7:04	284	14	38.9821	-25.3243	73	300	y	y	y	y
10/11/2008	7:06	285	16	36.0115	-27.7373	77	1	y	y	y	y
10/11/2008	7:06	285	16	36.0115	-27.7373	78	16	y	y	y	y
10/11/2008	7:06	285	16	36.0115	-27.7373	79	30	y	y	y	y
10/11/2008	7:06	285	16	36.0115	-27.7373	80	55	y	y	y	y
10/11/2008	7:06	285	16	36.0115	-27.7373	81	129	y	y	y	y
10/11/2008	7:06	285	16	36.0115	-27.7373	82	193	y	y	y	y
10/11/2008	7:06	285	16	36.0115	-27.7373	83	200	y	y	y	y
10/11/2008	7:06	285	16	36.0115	-27.7373	84	300	y	y	y	y
10/11/2008	13:55	285	17	35.3137	-28.4663	86	1	y	y	y	y
10/11/2008	13:55	285	17	35.3137	-28.4663	87	13	y	y		y
10/11/2008	13:55	285	17	35.3137	-28.4663	88	25	y	y		y
10/11/2008	13:55	285	17	35.3137	-28.4663	89	44	y	y		y
10/11/2008	13:55	285	17	35.3137	-28.4663	90	102	y	y		y
10/11/2008	13:55	285	17	35.3137	-28.4663	91	156	y	y		y
10/12/2008	6:58	286	19	33.2978	-30.7968	94	1	y	y	y	y
10/12/2008	6:58	286	19	33.2978	-30.7968	95	11	y	y	y	y
10/12/2008	6:58	286	19	33.2978	-30.7968	96	21	y	y	y	y

10/12/2008	6:58	286	19	33.2978	-30.7968	97	37	y	y	y	y
10/12/2008	6:58	286	19	33.2978	-30.7968	98	88	y	y	y	y
10/12/2008	6:58	286	19	33.2978	-30.7968	99	132	y	y	y	y
10/12/2008	6:58	286	19	33.2978	-30.7968	100	200	y	y	y	y
10/12/2008	6:58	286	19	33.2978	-30.7968	101	300	y	y	y	y
10/12/2008	13:57	286	20	32.4900	-31.7100	103	1	y	y	y	y
10/12/2008	13:57	286	20	32.4900	-31.7100	104	11	y	y		y
10/12/2008	13:57	286	20	32.4900	-31.7100	105	22	y	y		y
10/12/2008	13:57	286	20	32.4900	-31.7100	106	39	y	y		y
10/12/2008	13:57	286	20	32.4900	-31.7100	107	91	y	y		y
10/12/2008	13:57	286	20	32.4900	-31.7100	108	137	y	y		y
10/13/2008	7:08	287	22	30.4723	-33.9512	111	1	y	y	y	y
10/13/2008	7:08	287	22	30.4723	-33.9512	112	14	y	y	y	y
10/13/2008	7:08	287	22	30.4723	-33.9512	113	27	y	y	y	y
10/13/2008	7:08	287	22	30.4723	-33.9512	114	48	y	y	y	y
10/13/2008	7:08	287	22	30.4723	-33.9512	115	113	y	y	y	y
10/13/2008	7:08	287	22	30.4723	-33.9512	116	170	y	y	y	y
10/13/2008	7:08	287	22	30.4723	-33.9512	117	200	y	y	y	y
10/13/2008	7:08	287	22	30.4723	-33.9512	118	300	y	y	y	y
10/13/2008	13:48	287	23	29.6697	-34.8333	120	1	y	y	y	y
10/13/2008	13:48	287	23	29.6697	-34.8333	121	14	y	y		y
10/13/2008	13:48	287	23	29.6697	-34.8333	122	27	y	y		y
10/13/2008	13:48	287	23	29.6697	-34.8333	123	49	y	y		y
10/13/2008	13:48	287	23	29.6697	-34.8333	124	115	y	y		y
10/13/2008	13:48	287	23	29.6697	-34.8333	125	172	y	y		y
10/14/2008	6:53	288	25	27.6316	-37.0305	128	1	y	y	y	y
10/14/2008	6:53	288	25	27.6316	-37.0305	129	19	y	y	y	y
10/14/2008	6:53	288	25	27.6316	-37.0305	130	31	y	y	y	y
10/14/2008	6:53	288	25	27.6316	-37.0305	131	55	y	y	y	y
10/14/2008	6:53	288	25	27.6316	-37.0305	132	129	y	y	y	y
10/14/2008	6:53	288	25	27.6316	-37.0305	133	193	y	y	y	y
10/14/2008	6:53	288	25	27.6316	-37.0305	134	240	y	y	y	y
10/14/2008	6:53	288	25	27.6316	-37.0305	135	300	y	y	y	y
10/14/2008	13:47	288	26	26.8131	-37.8954	137	1	y	y	y	y
10/14/2008	13:47	288	26	26.8131	-37.8954	138	14	y	y		y
10/14/2008	13:47	288	26	26.8131	-37.8954	139	27	y	y		y
10/14/2008	13:47	288	26	26.8131	-37.8954	140	49	y	y		y
10/14/2008	13:47	288	26	26.8131	-37.8954	141	115	y	y		y
10/14/2008	13:47	288	26	26.8131	-37.8954	142	172	y	y		y
10/15/2008	6:54	289	28	24.7443	-40.0884	145	1	y	y	y	y
10/15/2008	6:54	289	28	24.7443	-40.0884	146	14	y	y	y	y
10/15/2008	6:54	289	28	24.7443	-40.0884	147	27	y	y	y	y
10/15/2008	6:54	289	28	24.7443	-40.0884	148	49	y	y	y	y
10/15/2008	6:54	289	28	24.7443	-40.0884	149	115	y	y	y	y
10/15/2008	6:54	289	28	24.7443	-40.0884	150	172	y	y	y	y
10/15/2008	6:54	289	28	24.7443	-40.0884	151	200	y	y	y	y
10/15/2008	6:54	289	28	24.7443	-40.0884	152	300	y	y	y	y
10/15/2008	10:29	289	29	24.7443	-40.0883	153	1000	y	y	y	y
10/15/2008	10:29	289	29	24.7443	-40.0883	154	2000	y	y	y	y
10/15/2008	10:29	289	29	24.7443	-40.0883	155	3000	y	y	y	y
10/15/2008	10:29	289	29	24.7443	-40.0883	156	4000	y	y	y	y
10/15/2008	14:27	289	30	24.7381	-40.0700	157	1	y	y	y	y
10/15/2008	14:27	289	30	24.7381	-40.0700	158	14	y	y		y

10/15/2008	14:27	289	30	24.7381	-40.0700	159	27	y	y		y
10/15/2008	14:27	289	30	24.7381	-40.0700	160	49	y	y		y
10/15/2008	14:27	289	30	24.7381	-40.0700	161	115	y	y		y
10/15/2008	14:27	289	30	24.7381	-40.0700	162	172	y	y		y
10/16/2008	6:55	290	32	22.5998	-40.2658	165	1	y	y	y	y
10/16/2008	6:55	290	32	22.5998	-40.2658	166	16	y	y	y	y
10/16/2008	6:55	290	32	22.5998	-40.2658	167	30	y	y	y	y
10/16/2008	6:55	290	32	22.5998	-40.2658	168	53	y	y	y	y
10/16/2008	6:55	290	32	22.5998	-40.2658	169	124	y	y	y	y
10/16/2008	6:55	290	32	22.5998	-40.2658	170	187	y	y	y	y
10/16/2008	6:55	290	32	22.5998	-40.2658	171	200	y	y	y	y
10/16/2008	6:55	290	32	22.5998	-40.2658	172	300	y	y	y	y
10/16/2008	13:50	290	33	21.6733	-39.5963	174	1	y	y	y	y
10/16/2008	13:50	290	33	21.6733	-39.5963	175	16	y	y		y
10/16/2008	13:50	290	33	21.6733	-39.5963	176	30	y	y		y
10/16/2008	13:50	290	33	21.6733	-39.5963	177	53	y	y		y
10/16/2008	13:50	290	33	21.6733	-39.5963	178	124	y	y		y
10/16/2008	13:50	290	33	21.6733	-39.5963	179	187	y	y		y
10/17/2008	6:53	291	35	19.7224	-38.2301	182	1	y	y	y	y
10/17/2008	6:53	291	35	19.7224	-38.2301	183	15	y	y	y	y
10/17/2008	6:53	291	35	19.7224	-38.2301	184	28	y	y	y	y
10/17/2008	6:53	291	35	19.7224	-38.2301	185	49	y	y	y	y
10/17/2008	6:53	291	35	19.7224	-38.2301	186	110	y	y	y	y
10/17/2008	6:53	291	35	19.7224	-38.2301	187	173	y	y	y	y
10/17/2008	6:53	291	35	19.7224	-38.2301	188	200	y	y	y	y
10/17/2008	6:53	291	35	19.7224	-38.2301	189	300	y	y	y	y
10/17/2008	13:48	291	36	18.7886	-37.5778	191	1	y	y	y	y
10/17/2008	13:48	291	36	18.7886	-37.5778	192	15	y	y		y
10/17/2008	13:48	291	36	18.7886	-37.5778	193	28	y	y		y
10/17/2008	13:48	291	36	18.7886	-37.5778	194	49	y	y		y
10/17/2008	13:48	291	36	18.7886	-37.5778	195	115	y	y		y
10/17/2008	13:48	291	36	18.7886	-37.5778	196	173	y	y		y
10/18/2008	6:58	292	38	16.8105	-36.2067	199	1	y	y	y	y
10/18/2008	6:58	292	38	16.8105	-36.2067	200	13	y	y	y	y
10/18/2008	6:58	292	38	16.8105	-36.2067	201	24	y	y	y	y
10/18/2008	6:58	292	38	16.8105	-36.2067	202	43	y	y	y	y
10/18/2008	6:58	292	38	16.8105	-36.2067	203	100	y	y	y	y
10/18/2008	6:58	292	38	16.8105	-36.2067	204	150	y	y	y	y
10/18/2008	6:58	292	38	16.8105	-36.2067	205	200	y	y	y	y
10/18/2008	6:58	292	38	16.8105	-36.2067	206	300	y	y	y	y
10/18/2008	14:30	292	40	16.8106	-36.2067	207	1	y	y	y	y
10/18/2008	14:30	292	40	16.8106	-36.2067	208	13	y	y		y
10/18/2008	14:30	292	40	16.8106	-36.2067	209	24	y	y		y
10/18/2008	14:30	292	40	16.8106	-36.2067	210	43	y	y		y
10/18/2008	14:30	292	40	16.8106	-36.2067	211	100	y	y		y
10/18/2008	14:30	292	40	16.8106	-36.2067	212	150	y	y		y
10/19/2008	6:55	293	42	14.9192	-34.9220	215	1	y	y	y	y
10/19/2008	6:55	293	42	14.9192	-34.9220	217	21	y	y	y	y
10/19/2008	6:55	293	42	14.9192	-34.9220	218	37	y	y	y	y
10/19/2008	6:55	293	42	14.9192	-34.9220	219	87	y	y	y	y
10/19/2008	6:55	293	42	14.9192	-34.9220	220	130	y	y	y	y
10/19/2008	6:55	293	42	14.9192	-34.9220	221	200	y	y	y	y
10/19/2008	6:55	293	42	14.9192	-34.9220	222	300	y	y	y	y

10/19/2008	13:55	293	43	14.0933	-34.3601	224	1	y	y	y	y
10/19/2008	13:55	293	43	14.0933	-34.3601	225	11	y	y		y
10/19/2008	13:55	293	43	14.0933	-34.3601	226	21	y	y		y
10/19/2008	13:55	293	43	14.0933	-34.3601	227	37	y	y		y
10/19/2008	13:55	293	43	14.0933	-34.3601	228	87	y	y		y
10/19/2008	13:55	293	43	14.0933	-34.3601	229	130	y	y		y
10/20/2008	7:05	294	45	11.8207	-32.8241	232	1	y	y	y	y
10/20/2008	7:05	294	45	11.8207	-32.8241	233	8	y	y	y	y
10/20/2008	7:05	294	45	11.8207	-32.8241	234	15	y	y	y	y
10/20/2008	7:05	294	45	11.8207	-32.8241	235	27	y	y	y	y
10/20/2008	7:05	294	45	11.8207	-32.8241	236	64	y	y	y	y
10/20/2008	7:05	294	45	11.8207	-32.8241	237	96	y	y	y	y
10/20/2008	7:05	294	45	11.8207	-32.8241	238	200	y	y	y	y
10/20/2008	7:05	294	45	11.8207	-32.8241	239	300	y	y	y	y
10/20/2008	13:53	294	46	10.8916	-32.2064	241	1	y	y	y	y
10/20/2008	13:53	294	46	10.8916	-32.2064	242	8	y	y		y
10/20/2008	13:53	294	46	10.8916	-32.2064	243	15	y	y		y
10/20/2008	13:53	294	46	10.8916	-32.2064	244	27	y	y		y
10/20/2008	13:53	294	46	10.8916	-32.2064	245	64	y	y		y
10/20/2008	13:53	294	46	10.8916	-32.2064	246	96	y	y		y
10/21/2008	6:44	295	48	8.6438	-30.7084	249	1	y	y	y	y
10/21/2008	6:44	295	48	8.6438	-30.7084	250	9	y	y	y	y
10/21/2008	6:44	295	48	8.6438	-30.7084	251	16	y	y	y	y
10/21/2008	6:44	295	48	8.6438	-30.7084	252	28	y	y	y	y
10/21/2008	6:44	295	48	8.6438	-30.7084	253	66	y	y	y	y
10/21/2008	6:44	295	48	8.6438	-30.7084	254	98	y	y	y	y
10/21/2008	6:44	295	48	8.6438	-30.7084	255	200	y	y	y	y
10/21/2008	6:44	295	48	8.6438	-30.7084	256	300	y	y	y	y
10/21/2008	13:49	295	49	7.6627	-30.0593	258	1	y	y	y	y
10/21/2008	13:49	295	49	7.6627	-30.0593	259	9	y	y		y
10/21/2008	13:49	295	49	7.6627	-30.0593	260	16	y	y		y
10/21/2008	13:49	295	49	7.6627	-30.0593	261	28	y	y		y
10/21/2008	13:49	295	49	7.6627	-30.0593	262	66	y	y		y
10/21/2008	13:49	295	49	7.6627	-30.0593	263	99	y	y		y
10/22/2008	6:53	296	51	5.3397	-28.5213	266	1	y	y	y	y
10/22/2008	6:53	296	51	5.3397	-28.5213	267	10	y	y	y	y
10/22/2008	6:53	296	51	5.3397	-28.5213	268	19	y	y	y	y
10/22/2008	6:53	296	51	5.3397	-28.5213	269	34	y	y	y	y
10/22/2008	6:53	296	51	5.3397	-28.5213	270	79	y	y	y	y
10/22/2008	6:53	296	51	5.3397	-28.5213	271	188	y	y	y	y
10/22/2008	6:53	296	51	5.3397	-28.5213	272	200	y	y	y	y
10/22/2008	6:53	296	51	5.3397	-28.5213	273	300	y	y	y	y
10/22/2008	14:00	296	54	5.1390	-28.3909	274	1	y	y	y	y
10/22/2008	14:00	296	54	5.1390	-28.3909	275	10	y	y		y
10/22/2008	14:00	296	54	5.1390	-28.3909	276	19	y	y		y
10/22/2008	14:00	296	54	5.1390	-28.3909	277	34	y	y		y
10/22/2008	14:00	296	54	5.1390	-28.3909	278	79	y	y		y
10/22/2008	14:00	296	54	5.1390	-28.3909	279	118	y	y		y
10/23/2008	6:47	297	56	2.7925	-26.8546	282	1	y	y	y	y
10/23/2008	6:47	297	56	2.7925	-26.8546	283	10	y	y	y	y
10/23/2008	6:47	297	56	2.7925	-26.8546	284	19	y	y	y	y
10/23/2008	6:47	297	56	2.7925	-26.8546	285	34	y	y	y	y
10/23/2008	6:47	297	56	2.7925	-26.8546	286	79	y	y	y	y

10/23/2008	6:47	297	56	2.7925	-26.8546	287	119	y	y	y	y
10/23/2008	6:47	297	56	2.7925	-26.8546	288	200	y	y	y	y
10/23/2008	6:47	297	56	2.7925	-26.8546	289	300	y	y	y	y
10/23/2008	13:49	297	57	1.8306	-26.2153	291	1	y	y	y	y
10/23/2008	13:49	297	57	1.8306	-26.2153	292	10	y	y		y
10/23/2008	13:49	297	57	1.8306	-26.2153	293	19	y	y		y
10/23/2008	13:49	297	57	1.8306	-26.2153	294	34	y	y		y
10/23/2008	13:49	297	57	1.8306	-26.2153	295	79	y	y		y
10/23/2008	13:49	297	57	1.8306	-26.2153	296	119	y	y		y
10/24/2008	6:47	298	59	-0.5793	-24.9939	299	1	y	y	y	y
10/24/2008	6:47	298	59	-0.5793	-24.9939	300	13	y	y	y	y
10/24/2008	6:47	298	59	-0.5793	-24.9939	301	24	y	y	y	y
10/24/2008	6:47	298	59	-0.5793	-24.9939	302	43	y	y	y	y
10/24/2008	6:47	298	59	-0.5793	-24.9939	303	100	y	y	y	y
10/24/2008	6:47	298	59	-0.5793	-24.9939	304	150	y	y	y	y
10/24/2008	6:47	298	59	-0.5793	-24.9939	305	200	y	y	y	y
10/24/2008	6:47	298	59	-0.5793	-24.9939	306	300	y	y	y	y
10/24/2008	13:23	298	60	-1.6242	-24.9970	308	1	y	y	y	y
10/24/2008	13:23	298	60	-1.6242	-24.9970	309	13	y	y		y
10/24/2008	13:23	298	60	-1.6242	-24.9970	310	24	y	y		y
10/24/2008	13:23	298	60	-1.6242	-24.9970	311	43	y	y		y
10/24/2008	13:23	298	60	-1.6242	-24.9970	312	100	y	y		y
10/24/2008	13:23	298	60	-1.6242	-24.9970	313	150	y	y		y
10/25/2008	14:04	299	61	-6.0524	-24.9771	317	1	y	y	y	y
10/25/2008	14:04	299	61	-6.0524	-24.9771	318	12	y	y		y
10/25/2008	14:04	299	61	-6.0524	-24.9771	319	21	y	y		y
10/25/2008	14:04	299	61	-6.0524	-24.9771	320	37	y	y		y
10/25/2008	14:04	299	61	-6.0524	-24.9771	321	87	y	y		y
10/25/2008	14:04	299	61	-6.0524	-24.9771	322	130	y	y		y
10/26/2008	6:46	300	63	-8.8254	-24.9953	325	1	y	y	y	y
10/26/2008	6:46	300	63	-8.8254	-24.9953	326	14	y	y	y	y
10/26/2008	6:46	300	63	-8.8254	-24.9953	327	25	y	y	y	y
10/26/2008	6:46	300	63	-8.8254	-24.9953	328	45	y	y	y	y
10/26/2008	6:46	300	63	-8.8254	-24.9953	329	104	y	y	y	y
10/26/2008	6:46	300	63	-8.8254	-24.9953	330	157	y	y	y	y
10/26/2008	6:46	300	63	-8.8254	-24.9953	331	200	y	y	y	y
10/26/2008	6:46	300	63	-8.8254	-24.9953	332	300	y	y	y	y
10/26/2008	13:46	300	64	-9.9753	-24.9994	334	1	y	y	y	y
10/26/2008	13:46	300	64	-9.9753	-24.9994	335	14	y	y		y
10/26/2008	13:46	300	64	-9.9753	-24.9994	336	25	y	y		y
10/26/2008	13:46	300	64	-9.9753	-24.9994	337	45	y	y		y
10/26/2008	13:46	300	64	-9.9753	-24.9994	338	105	y	y		y
10/26/2008	13:46	300	64	-9.9753	-24.9994	339	157	y	y		y
10/27/2008	6:48	301	66	-12.8396	-24.9982	342	1	y	y	y	y
10/27/2008	6:48	301	66	-12.8396	-24.9982	343	14	y	y	y	y
10/27/2008	6:48	301	66	-12.8396	-24.9982	344	25	y	y	y	y
10/27/2008	6:48	301	66	-12.8396	-24.9982	345	45	y	y	y	y
10/27/2008	6:48	301	66	-12.8396	-24.9982	346	105	y	y	y	y
10/27/2008	6:48	301	66	-12.8396	-24.9982	347	157	y	y	y	y
10/27/2008	6:48	301	66	-12.8396	-24.9982	348	200	y	y	y	y
10/27/2008	6:48	301	66	-12.8396	-24.9982	349	300	y	y	y	y
10/27/2008	13:50	301	67	-13.9944	-24.9952	351	1	y	y	y	y
10/27/2008	13:50	301	67	-13.9944	-24.9952	352	14	y	y		y

10/27/2008	13:50	301	67	-13.9944	-24.9952	353	25	y	y		y
10/27/2008	13:50	301	67	-13.9944	-24.9952	354	45	y	y		y
10/27/2008	13:50	301	67	-13.9944	-24.9952	355	105	y	y		y
10/27/2008	13:50	301	67	-13.9944	-24.9952	356	157	y	y		y
10/28/2008	6:48	302	70	-16.6377	-24.9938	359	1	y	y	y	y
10/28/2008	6:48	302	70	-16.6377	-24.9938	360	18	y	y	y	y
10/28/2008	6:48	302	70	-16.6377	-24.9938	361	32	y	y	y	y
10/28/2008	6:48	302	70	-16.6377	-24.9938	362	58	y	y	y	y
10/28/2008	6:48	302	70	-16.6377	-24.9938	363	135	y	y	y	y
10/28/2008	6:48	302	70	-16.6377	-24.9938	364	203	y	y	y	y
10/28/2008	6:48	302	70	-16.6377	-24.9938	365	300	y	y	y	y
10/28/2008	9:57	302	71	-16.6377	-24.9938	366	1000	y	y	y	y
10/28/2008	9:57	302	71	-16.6377	-24.9938	367	2000	y	y	y	y
10/28/2008	9:57	302	71	-16.6377	-24.9938	368	3000	y	y	y	y
10/28/2008	9:57	302	71	-16.6377	-24.9938	369	4000	y	y	y	y
10/28/2008	13:52	302	72	-16.8754	-24.9961	370	1	y	y	y	y
10/28/2008	13:52	302	72	-16.8754	-24.9961	371	18	y	y		y
10/28/2008	13:52	302	72	-16.8754	-24.9961	372	32	y	y		y
10/28/2008	13:52	302	72	-16.8754	-24.9961	373	58	y	y		y
10/28/2008	13:52	302	72	-16.8754	-24.9961	374	135	y	y		y
10/28/2008	13:52	302	72	-16.8754	-24.9961	375	203	y	y		y
10/29/2008	6:47	303	75	-19.1236	-24.9959	378	1	y	y	y	y
10/29/2008	6:47	303	75	-19.1236	-24.9959	379	16	y	y	y	y
10/29/2008	6:47	303	75	-19.1236	-24.9959	380	30	y	y	y	y
10/29/2008	6:47	303	75	-19.1236	-24.9959	381	53	y	y	y	y
10/29/2008	6:47	303	75	-19.1236	-24.9959	382	125	y	y	y	y
10/29/2008	6:47	303	75	-19.1236	-24.9959	383	187	y	y	y	y
10/29/2008	6:47	303	75	-19.1236	-24.9959	384	240	y	y	y	y
10/29/2008	6:47	303	75	-19.1236	-24.9959	385	300	y	y	y	y
10/29/2008	13:50	303	76	-20.2832	-25.0012	387	1	y	y	y	y
10/29/2008	13:50	303	76	-20.2832	-25.0012	388	16	y	y		y
10/29/2008	13:50	303	76	-20.2832	-25.0012	389	30	y	y		y
10/29/2008	13:50	303	76	-20.2832	-25.0012	390	53	y	y		y
10/29/2008	13:50	303	76	-20.2832	-25.0012	391	125	y	y		y
10/29/2008	13:50	303	76	-20.2832	-25.0012	392	187	y	y		y
10/30/2008	6:54	304	79	-22.7854	-25.0091	395	1	y	y	y	y
10/30/2008	6:54	304	79	-22.7854	-25.0091	396	16	y	y	y	y
10/30/2008	6:54	304	79	-22.7854	-25.0091	397	30	y	y	y	y
10/30/2008	6:54	304	79	-22.7854	-25.0091	398	53	y	y	y	y
10/30/2008	6:54	304	79	-22.7854	-25.0091	399	125	y	y	y	y
10/30/2008	6:54	304	79	-22.7854	-25.0091	400	187	y	y	y	y
10/30/2008	6:54	304	79	-22.7854	-25.0091	401	200	y	y	y	y
10/30/2008	6:54	304	79	-22.7854	-25.0091	402	300	y	y	y	y
10/30/2008	13:50	304	80	-23.9345	-24.9993	404	1	y	y	y	y
10/30/2008	13:50	304	80	-23.9345	-24.9993	405	16	y	y		y
10/30/2008	13:50	304	80	-23.9345	-24.9993	406	30	y	y		y
10/30/2008	13:50	304	80	-23.9345	-24.9993	407	53	y	y		y
10/30/2008	13:50	304	80	-23.9345	-24.9993	408	125	y	y		y
10/30/2008	13:50	304	80	-23.9345	-24.9993	409	187	y	y		y
10/31/2008	6:51	305	83	-26.5572	-24.9979	412	1	y	y	y	y
10/31/2008	6:51	305	83	-26.5572	-24.9979	413	20	y	y	y	y
10/31/2008	6:51	305	83	-26.5572	-24.9979	414	31	y	y	y	y
10/31/2008	6:51	305	83	-26.5572	-24.9979	415	55	y	y	y	y

10/31/2008	6:51	305	83	-26.5572	-24.9979	416	128	y	y	y	y
10/31/2008	6:51	305	83	-26.5572	-24.9979	417	192	y	y	y	y
10/31/2008	6:51	305	83	-26.5572	-24.9979	418	240	y	y	y	y
10/31/2008	6:51	305	83	-26.5572	-24.9979	419	300	y	y	y	y
10/31/2008	14:13	305	85	-26.5572	-24.9978	420	1	y	y	y	y
10/31/2008	14:13	305	85	-26.5572	-24.9978	421	17	y	y		y
10/31/2008	14:13	305	85	-26.5572	-24.9978	422	31	y	y		y
10/31/2008	14:13	305	85	-26.5572	-24.9978	423	55	y	y		y
10/31/2008	14:13	305	85	-26.5572	-24.9978	424	128	y	y		y
10/31/2008	14:13	305	85	-26.5572	-24.9978	425	192	y	y		y
11/1/2008	6:46	306	87	-28.8683	-26.0362	428	1	y	y	y	y
11/1/2008	6:46	306	87	-28.8683	-26.0362	429	14	y	y	y	y
11/1/2008	6:46	306	87	-28.8683	-26.0362	430	26	y	y	y	y
11/1/2008	6:46	306	87	-28.8683	-26.0362	431	47	y	y	y	y
11/1/2008	6:46	306	87	-28.8683	-26.0362	432	110	y	y	y	y
11/1/2008	6:46	306	87	-28.8683	-26.0362	433	165	y	y	y	y
11/1/2008	6:46	306	87	-28.8683	-26.0362	434	200	y	y	y	y
11/1/2008	6:46	306	87	-28.8683	-26.0362	435	300	y	y	y	y
11/2/2008	15:01	307	88	-32.1788	-29.8255	442	1	y	y	y	y
11/2/2008	15:01	307	88	-32.1788	-29.8255	443	13	y	y		y
11/2/2008	15:01	307	88	-32.1788	-29.8255	444	25	y	y		y
11/2/2008	15:01	307	88	-32.1788	-29.8255	445	45	y	y		y
11/2/2008	15:01	307	88	-32.1788	-29.8255	446	105	y	y		y
11/2/2008	15:01	307	88	-32.1788	-29.8255	447	158	y	y		y
11/3/2008	7:55	308	91	-33.7682	-32.0031	450	1	y	y	y	y
11/3/2008	7:55	308	91	-33.7682	-32.0031	451	9	y	y	y	y
11/3/2008	7:55	308	91	-33.7682	-32.0031	452	17	y	y	y	y
11/3/2008	7:55	308	91	-33.7682	-32.0031	453	30	y	y	y	y
11/3/2008	7:55	308	91	-33.7682	-32.0031	454	71	y	y	y	y
11/3/2008	7:55	308	91	-33.7682	-32.0031	455	106	y	y	y	y
11/3/2008	7:55	308	91	-33.7682	-32.0031	456	200	y	y	y	y
11/3/2008	7:55	308	91	-33.7682	-32.0031	457	300	y	y	y	y
11/3/2008	15:02	308	92	-34.5532	-32.9805	459	1	y	y	y	y
11/3/2008	15:02	308	92	-34.5532	-32.9805	460	9	y	y		y
11/3/2008	15:02	308	92	-34.5532	-32.9805	461	17	y	y		y
11/3/2008	15:02	308	92	-34.5532	-32.9805	462	330	y	y		y
11/3/2008	15:02	308	92	-34.5532	-32.9805	463	71	y	y		y
11/3/2008	15:02	308	92	-34.5532	-32.9805	464	106	y	y		y
11/4/2008	6:53	309	94	-36.1734	-35.0541	466	1	y	y	y	y
11/4/2008	6:53	309	94	-36.1734	-35.0541	467	8	y	y	y	y
11/4/2008	6:53	309	94	-36.1734	-35.0541	468	15	y	y	y	y
11/4/2008	6:53	309	94	-36.1734	-35.0541	469	27	y	y	y	y
11/4/2008	6:53	309	94	-36.1734	-35.0541	470	65	y	y	y	y
11/4/2008	6:53	309	94	-36.1734	-35.0541	471	98	y	y	y	y
11/4/2008	6:53	309	94	-36.1734	-35.0541	472	200	y	y	y	y
11/4/2008	6:53	309	94	-36.1734	-35.0541	473	300	y	y	y	y
11/4/2008	14:50	309	95	-36.1731	-35.0542	475	1	y	y	y	y
11/4/2008	14:50	309	95	-36.1731	-35.0542	476	8	y	y		y
11/4/2008	14:50	309	95	-36.1731	-35.0542	477	15	y	y		y
11/4/2008	14:50	309	95	-36.1731	-35.0542	478	27	y	y		y
11/4/2008	14:50	309	95	-36.1731	-35.0542	479	65	y	y		y
11/4/2008	14:50	309	95	-36.1731	-35.0542	480	98	y	y		y
11/5/2008	6:54	310	97	-37.9633	-37.4040	483	1	y	y	y	y

11/5/2008	6:54	310	97	-37.9633	-37.4040	484	6	y	y	y	y
11/5/2008	6:54	310	97	-37.9633	-37.4040	485	12	y	y	y	y
11/5/2008	6:54	310	97	-37.9633	-37.4040	486	21	y	y	y	y
11/5/2008	6:54	310	97	-37.9633	-37.4040	487	50	y	y	y	y
11/5/2008	6:54	310	97	-37.9633	-37.4040	488	76	y	y	y	y
11/5/2008	6:54	310	97	-37.9633	-37.4040	489	200	y	y	y	y
11/5/2008	6:54	310	97	-37.9633	-37.4040	490	300	y	y	y	y
11/5/2008	14:42	310	98	-38.7624	-38.4591	492	1	y	y	y	y
11/5/2008	14:42	310	98	-38.7624	-38.4591	493	6	y	y		y
11/5/2008	14:42	310	98	-38.7624	-38.4591	494	12	y	y		y
11/5/2008	14:42	310	98	-38.7624	-38.4591	495	21	y	y		y
11/5/2008	14:42	310	98	-38.7624	-38.4591	496	50	y	y		y
11/5/2008	14:42	310	98	-38.7624	-38.4591	497	76	y	y		y
11/6/2008	14:47	311	99	-41.4768	-42.1396	502	1	y	y	y	y
11/6/2008	14:47	311	99	-41.4768	-42.1396	503	6	y	y		y
11/6/2008	14:47	311	99	-41.4768	-42.1396	504	12	y	y		y
11/6/2008	14:47	311	99	-41.4768	-42.1396	505	21	y	y		y
11/6/2008	14:47	311	99	-41.4768	-42.1396	506	49	y	y		y
11/6/2008	14:47	311	99	-41.4768	-42.1396	507	74	y	y		y
11/7/2008	6:56	312	101	-43.2267	-44.6134	509	1	y	y	y	y
11/7/2008	6:56	312	101	-43.2267	-44.6134	510	3	y	y	y	y
11/7/2008	6:56	312	101	-43.2267	-44.6134	511	6	y	y	y	y
11/7/2008	6:56	312	101	-43.2267	-44.6134	512	12	y	y	y	y
11/7/2008	6:56	312	101	-43.2267	-44.6134	513	26	y	y	y	y
11/7/2008	6:56	312	101	-43.2267	-44.6134	514	39	y	y	y	y
11/7/2008	6:56	312	101	-43.2267	-44.6134	515	200	y	y	y	y
11/7/2008	6:56	312	101	-43.2267	-44.6134	516	300	y	y	y	y
11/7/2008	14:35	312	102	-43.9473	-45.6474	518	1	y	y	y	y
11/7/2008	14:35	312	102	-43.9473	-45.6474	519	7	y	y		y
11/7/2008	14:35	312	102	-43.9473	-45.6474	521	25	y	y		y
11/7/2008	14:35	312	102	-43.9473	-45.6474	522	59	y	y		y
11/7/2008	14:35	312	102	-43.9473	-45.6474	523	88	y	y		y

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SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN

Except for the data already described on page 2 under 'Moorings, Bottom Mounted Gear and Drifting Systems', this section should include a summary of all data collected on the cruise, whether they be measurements (e.g. temperature, salinity values) or samples (e.g. cores, net hauls).

Separate entries should be made for each distinct and coherent set of measurements or samples. Different modes of data collection (e.g. vertical profiles as opposed to underway measurements) should be clearly distinguished, as should measurements/sampling techniques that imply distinctly different accuracy's or spatial/temporal resolutions. Thus, for example, separate entries would be created for i) BT drops, ii) water bottle stations, iii) CTD casts, iv) towed CTD, v) towed undulating CTD profiler, vi) surface water intake measurements, etc.

Each data set entry should start on a new line – it's description may extend over several lines if necessary.

NO, UNITS : for each data set, enter the estimated amount of data collected expressed in terms of the number of 'stations'; miles' of track; 'days' of

recording; 'cores' taken; net 'hauls'; balloon 'ascents'; or whatever unit is most appropriate to the data. The amount should be entered

under 'NO' and the counting unit should be identified in plain text under 'UNITS'.

PI	NO see above	UNITS see above	DATA TYPE	DESCRIPTION Identify, as appropriate, the nature of the data and of the instrumentation/sampling gear and list the parameters measured. Include any supplementary information that may be appropriate, e. g. vertical or horizontal profiles, depth horizons, continuous recording or discrete samples, etc. For samples taken for later analysis on shore, an indication should be given of the type of analysis planned, i.e. the purpose for which the samples were taken.
	36	Days		Water leaving radiance, sky radiance and surface irradiance at 7 wavelengths (443,490,510,555,670,780 and 865 nm). Collected during daylight hours.
	36	Days		Continuous underway sampling from de-aerated non-toxic seawater system measuring temperature, salinity, fluorescence, backscatter at 530nm, acid labile backscatter at 530nm and absorption and attenuation at 9 wavelengths (412,440,488,510,555,630,650,676 and 715nm), alternating every 2 minutes between total and 0.2 micron filtered
	100	Samples		Discrete filtered samples from the non-toxic seawater system for Particulate Inorganic Carbon
	100	Samples		Discrete filtered samples from the non-toxic seawater system for Biogenic Silica
	100	Samples		Discrete filtered samples from the non-toxic seawater system for microscope enumeration of coccolithophores and coccoliths
	100	Samples		Discrete filtered samples from the non-toxic seawater system for Particulate Organic Carbon
	425	Samples		Filtered samples from CTD casts for Particulate Inorganic Carbon
	425	Samples		Filtered samples from CTD casts for Biogenic Silica
	425	Samples		Filtered samples from CTD for Particulate Organic Carbon
	276	Samples		Filtered samples from CTD casts for microscope enumeration of coccolithophores and coccoliths

Dissolved Oxygen; Photosynthesis-Respiration; Photochemical Oxygen Demand

Vassilis Kitidis,
Plymouth Marine Laboratory, PL1 3DH, UK, vak@pml.ac.uk

POGO-AMT fellowship

In 2008, Mr. Mario Vera (Universidad de la Republica, Uruguay) was awarded the Partnership for the Observation of the Global Ocean (POGO)-AMT training fellowship. The fellowship enabled Mr. Vera's participation in the AMT 18 research cruise, including pre-cruise mobilisation and post-cruise preliminary data analysis. Dr. Vassilis Kitidis acted as the host supervisor at the Plymouth Marine Laboratory and onboard RRS ***James Clark Ross***. Mr. Vera received training in dissolved Oxygen analysis and the determination of production, respiration and photochemical oxygen demand described in detail below. The scope of his training was broadened through interactions with other scientific personnel during AMT 18.

Background

Dissolved Oxygen (O_2) in seawater is produced by photosynthesis and consumed by respiration and photochemical reactions in the surface. Equilibrium between dissolved O_2 in seawater and the atmosphere is maintained through air-sea gas exchange. Previous work on the AMT programme has shown that gross community respiration may at times exceed production of O_2 integrated over the euphotic layer (Robinson et al., 2002; Serret et al., 2001). Several cruises have shown that this result is not consistent in either space or time. These experiments suggest transient net heterotrophy in the open ocean. In addition, photochemical O_2 demand, linked to organic carbon remineralisation, may exceed biological respiration in the open ocean. The net trophic state of the oceans (autotrophic vs. heterotrophic) ultimately determines whether they act as a sink or a source for atmospheric carbon dioxide. Understanding the dynamics of O_2 is therefore necessary in order to improve biogeochemical models and associated climate change predictions. The AMT programme presents an ideal opportunity to study the biogeochemical interactions between photosynthesis, respiration and photo-consumption on the dynamics of dissolved O_2 across diverse marine biomes. The aims of this work were:

1. To quantify gross community production and respiration of O_2 in surface waters.
2. To quantify the photochemical O_2 demand in surface waters.
3. To calibrate the O_2 sensor on the depth profiler.

Methods

Dissolved O_2 was determined by automated Winkler titration with photometric end-point detection (Carritt and Carpenter, 1966). The concentration of thiosulphate was calibrated every 2 days. Gross community production and respiration experiments were carried out according to Robinson et al. (2002). Briefly, seawater samples were collected daily from the pre-dawn depth profile in 10 L acid-washed carboys (6 depths within the euphotic zone). Each carboy was sub-sampled into 125 mL glass O_2 bottles which were placed in on-deck incubators for 24 hours. The incubators were covered with neutral density light filters and temperature controlled to ±2 ^{o}C in order to simulate ***in situ*** conditions. Additional subsamples were fixed and analysed at the start of the incubation ('zero' sub-samples) Light and dark (wrapped in Al foil) O_2 bottles were removed from the incubators, fixed and analysed for O_2. Each treatment for each depth (Zero, Light and Dark) was replicated four times. Community respiration (CR) was calculated as O_2 consumption in the dark samples (Dark-Zero). Net community production was calculated as O_2 production in light samples (Light-Dark).

Seawater samples for the determination of photochemical O_2 demand (POD) were collected from the pre-dawn depth profile (1 depth) in a 25 L acid-washed glass vessel. In addition, two deep water samples were collected in the North and South Atlantic respectively. The samples were sequentially filtered through 0.2 µm and 0.1 µm filters into a second 25 L acid-washed glass vessel. The filtrate was sub-sampled into 100 mL Quartz glass bottles and placed into artificial-light incubators for <24 h along with dark treatments. Additional

subsamples were fixed and analysed at the start of the incubation ('zero' sub-samples) Light and dark (wrapped in Al foil) O_2 bottles were removed from the incubators, fixed and analysed for O_2. Each treatment (Zero, Light and Dark) was replicated 4-6 times. POD was calculated as O_2 consumption in light samples (Light-Dark). Dark samples were not significantly different from 'zero' samples.

Seawater samples were collected daily from the afternoon depth profile (2-4 depths), fixed and analysed for O_2 for the calibration of the O_2 sensor on the depth profiler.

Results

In total, 24 experiments were carried out for the determination of community production/respiration (Table 1) and 17 experiments were carried out for the determination of photochemical O_2 demand (Table 2). Preliminary results show that the production/respiration experiments are in agreement with previous work (Robinson et al., 2002; Serret et al., 2001). Net autotrophy and net heterotrophy was encountered during AMT 18. Net heterotrophy was predominantly encountered in the northern hemisphere and South Atlantic gyre region, while net autotrophy was predominantly encountered near the Equator and on the Patagonian Shelf. Photochemical experiments showed consistent O_2 consumption. The concentration of O_2 was determined by Winkler titration in 76 discrete samples for the calibration of the O_2 sensor on the depth profiler (Table 3). The O_2 concentration data from the titrations and corresponding O_2 sensor data are shown in Figure 1. The data show that the O_2 sensor consistently underestimated the concentration of dissolved O_2. The two parameters were significantly correlated (R^2=0.998, $\boldsymbol{p}$<0.001) and the line of best fit was described by the equation.

$$[O_2 \text{ winkler}] \text{ (mg } L^{-1}) = 1.1067 \times [O_2 \text{ CTD}] \text{ (mg } L^{-1}) + 0.5173$$

When this correction is applied, surface O_2 data from the depth profiler are around 100 % saturation with respect to atmospheric equilibrium (~81 % without the correction). O_2 data from the Conductivity Temperature Depth sensor should therefore not be used without prior correction.

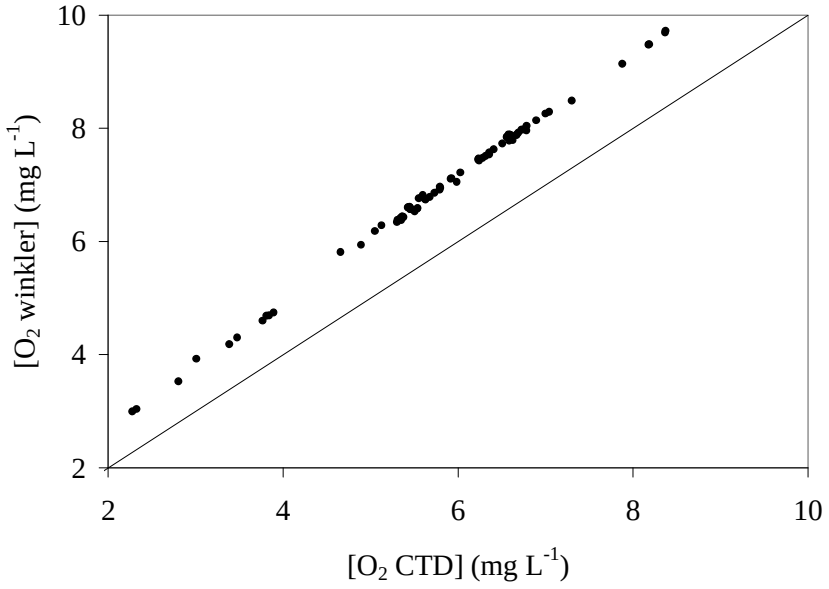

Figure 1: Calibration of O_2 sensor on the Conductivity Temperature Depth profiler during AMT 18 (JR 218). O_2 determined by Winkler titration against sensor data. The 1:1 line is shown.

Table 1: Station log for samples collected for production/respiration of O_2 during AMT 18 (JR218)

Station	Date	Depth	Niskin	Lat	Long
		(m)		(+ve: North)	deg W
JR218_015	11/10/2008	2,30,55,74,129,153	24,18,17,14,7,5	36.012	27.737
JR218_018	12/10/2008	2,21,50,88,67,132	24,18,14,9,13,4	33.298	30.747
JR218_021	13/10/2008	2,48,65,86,113,170	23,18,13,12,7,3	30.472	33.951
JR218_024	14/10/2008	2,55,74,98,129,193	23,18,13,12,7,4	27.632	37.030
JR218_027	15/10/2008	2,49,66,87,115,172	23,18,13,12,7,5	24.744	40.088
JR218_031	16/10/2008	2,53,72,95,124,187	23,18,13,12,8,4	22.600	40.266
JR218_034	17/10/2008	2,49,66,88,110,173	23,18,13,12,8,4	19.722	38.230
JR218_037	18/10/2008	2,43,58,76,100,150	23,18,13,12,6,4	16.811	36.207
JR218_041	19/10/2008	2,37,50,66,87,130	23,18,13,12,8,4	14.919	34.922
JR218_044	20/10/2008	2,15,27,37,52,96	23,19,18,12,8,4	11.821	32.824
JR218_047	21/10/2008	2,28,38,50,66,98	23,18,13,12,8,5	8.644	30.708
JR218_050	22/10/2008	2,34,46,60,79,118	23,18,13,12,6,4	5.340	28.521
JR218_055	23/10/2008	2,34,46,60,79,119	23,18,13,12,7,4	2.792	26.859
JR218_058	24/10/2008	2,43,58,76,100,150	23,18,13,12,7,4	-0.586	24.997
JR218_062	26/10/2008	2,45,60,80,105,157	23,18,13,12,7,4	-8.825	24.995
JR218_065	27/10/2008	2,45,60,80,105,157	23,18,13,12,10,4	-12.840	24.998
JR218_069	28/10/2008	2,58,78,103,145,203	23,18,13,12,16,4	-16.638	24.994
JR218_074	29/10/2008	2,53,72,95,125,187	23,18,13,12,10,4	-19.040	24.996
JR218_078	30/10/2008	2,53,72,95,145,187	23,18,13,12,6,4	-22.785	25.009
JR218_082	31/10/2008	2,55,74,97,128,192	23,18,13,12,7,4	-26.557	24.998
JR218_086	01/11/2008	2,47,63,84,110,165	23,18,13,12,8,4	-28.868	26.036
JR218_090	03/11/2008	2,9,30,41,54,71	23,21,18,13,12,6	-33.768	32.003
JR218_093	04/11/2008	2,8,27,37,49,65	23,15,18,13,12,10	-35.054	35.054
JR218_096	05/11/2008	2,6,21,29,38,50	23,20,18,13,12,9	-37.968	37.413

Table 2: Station log for photochemical oxygen consumption samples during AMT 18 (JR 218)

Station	Date	Depth	Niskin	Lat	Long
		(m)		(+ve: North)	deg W
JR218_003	05/10/2008	2	22	49.482	9.847
JR218_005	06/10/2008	6	22	49.149	14.652
JR218_011	09/10/2008	12	20	42.673	22.195
JR218_015	11/10/2008	55	16	36.012	27.737
JR218_020	13/10/2008	40	15	33.540	31.710
JR218_029	16/10/2008	3000	11	24.745	40.088
JR218_037	18/10/2008	2	22	16.811	36.207
JR218_044	20/10/2008	15	20	11.821	32.824
JR218_050	22/10/2008	46	15	5.340	28.521
JR218_058	24/10/2008	24	20	-0.586	24.997
JR218_063	26/10/2008	7	22	-8.825	24.995
JR218_068	28/10/2008	2	22	-14.993	24.994
JR218_078	30/10/2008	40	17	-22.785	25.009
JR218_084	01/11/2008	3000	8	-28.557	24.998
JR218_090	03/11/2008	54	11	-33.768	32.003
JR218_096	05/11/2008	29	16	-37.968	37.413
JR218_100	07/11/2008	2	20	-43.227	44.613

Table 3: Station log of samples analysed for the calibration of O_2 sensor on the Conductivity Temperature Depth profiler during AMT 18 (JR 218).

Station	Date	Niskin	Latitude	Longitude	Depth
			(+ve: North)	deg. W	m
JR218_004	05/10/2008	22,16,3	49.37	11.39	153,23,5
JR218_007	07/10/2008	3,14,16,22	48.87	16.20	77,23,11,4
JR218_017	11/10/2008	4,22,19	35.31	28.47	159,4,16
JR218_020	12/10/2008	4,22,19	32.49	31.71	141,7,16
JR218_029	15/10/2008	18,15,10,1	24.74	40.09	857,1340,3000,4686
JR218_033	16/10/2008	4,22,19	21.67	39.60	189,5,19
JR218_039	18/10/2008	18,15,7,1	16.81	36.21	406,779,2997,5143
JR218_043	19/10/2008	4,22,19	14.09	34.36	132,5,14
JR218_046	20/10/2008	4,22	10.89	32.21	98,5
JR218_049	21/10/2008	4,19,22	7.66	30.06	101,12,6
JR218_054	22/10/2008	4,19,22	5.14	28.39	121,15,5
JR218_057	23/10/2008	4,19,22	1.83	26.21	121,14,4
JR218_061	25/10/2008	19,22	6.05	24.98	15,7
JR218_064	26/10/2008	4,22,19	9.98	25.00	158,6,17
JR218_067	27/10/2008	4,19	13.99	25.00	158,18
JR218_071	28/10/2008	20,15,9	16.64	24.99	538,1005,2999
JR218_076	29/10/2008	4,22,19	20.28	25.01	189,5,20
JR218_080	30/10/2008	4,22,19	23.93	25.00	190,6,21
JR218_084	31/10/2008	15,1,9	28.56	25.00	1304,4566,2998
JR218_088	02/11/2008	4,22,19	32.18	29.83	161,7,18
JR218_092	03/11/2008	4,22,19	34.55	32.98	109,6,13
JR218_095	04/11/2008	4,22,19	36.17	35.05	99,6,12
JR218_098	05/11/2008	22,19,4	38.76	38.46	7,11,82
JR218_099	06/11/2008	4,22,19	41.47	42.15	77,10,17
JR218_102	07/11/2008	4,22,19	43.95	45.65	92,7,11

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Microbial plankton community abundance, structure and dynamics

Glen Tarran, Plymouth Marine Laboratory
Martin Ostrowski and John Pearman, University of Warwick
Manuela Hartmann, Ross Holland and Mike Zubkov, National Oceanography Centre

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

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

Objectives

- To determine the distribution, abundance and community structure of nano- and picophytoplankton, heterotrophic bacteria and heterotrophic nano- and picoplankton from predawn and solar noon CTD casts by flow cytometry. ***AMT core measurement.***
- To determine the distribution, abundance and community structure of planktonic phototrophic and heterotrophic bacteria and protists (flagellates) from high frequency underway sampling from the ship's pumped seawater supply by flow cytometry. ***AMT core measurement.***
- Collect and filter seawater samples for the post-cruise quantification of phytoplankton pigments and micosporine-like amino acids(MAAs) using High Performance Liquid Chromatography (HPLC) from predawn and solar noon CTD casts. ***AMT core measurement.***
- Trials of newly developed microplankton net and FlowCAM flow cytometer to characterise microplankton protist communities (size range 40-200 µm). ***AMT core measurement development.***

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

Fresh seawater samples were collected in clean 250 mL polycarbonate bottles from a Seabird CTD system containing a 24 bottle rosette of 10 and 20 L Niskin bottles from predawn and solar noon CTD casts. Samples were stored in a refrigerator and analysed within 1-2 hours of collection. Fresh samples were measured using a Becton Dickinson FACSort flow cytometer which characterised and enumerated ***Prochlorococcus*** sp. and ***Synechococcus*** sp. (cyanobacteria), pico-eucaryotes, cryptophytes, coccolithophores and other nanophytoplankton based on their light scattering and autofluorescence properties. The data were immediately stored on disk and will be analysed back in the UK. Table 1.1. summarises the CTD casts sampled and analysed during the cruise.

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

Underway samples were drawn every half an hour from the ships non-toxic seawater supply by an automated liquid handling robot (Tecan Miniprep 60, Tecan, Reading, UK). Samples were fixed instantly with paraformaldehyde and analysed flow cytometrically within 8 hours. Underway sampling began at 0930 on 06/10/08 and was discontinued at 1700 on 07/11/08.

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

DATE	CTD	TIME on deck (GMT)	Lat (N, -S)	Long W	**Depths sampled (m).** Heterotrophic bacteria and flagellates, all depths sampled. Depths highlighted in grey, depths sampled for phytoplankton
06-Oct	2	05:32	49° 28.9'	9° 50.9'	2 10 25 35 40 45 50 60 70 80 100 120 138
06-Oct	4	14:00	49° 22.3'	11° 23.4'	2 10 20 25 28 23 36 40 60 100 150 200 300
07-Oct	5	05:10	49° 9.0'	14° 39.1'	2 6 12 21 37 49 55 60 73 80 100 200 300
07-Oct	7	13:40	48° 52.4'	16° 11.8'	2 6 12 21 35 45 49 55 73 100 200 300
08-Oct	8	05:10	46° 33.4'	18° 41.8'	2 7 13 23 41 45 50 54 65 81 90 120 200 300
09-Oct	11	05:00	42° 40.3'	22° 11.7'	2 12 22 40 72 78 85 95 110 143 150 160 200 300
10-Oct	13	04:58	38° 40.3'	25° 19.5'	2 13 24 43 60 65 70 78 85 102 130 153 200 300
11-Oct	15	06:10	36° 52.9'	27° 44.2'	2 16 30 55 74 80 85 90 98 129 150 193 240 300
11-Oct	17	14:22	38° 18.9'	28° 28.2'	2 13 25 44 60 81 90 104 120 156 200 300
12-Oct	18	06:01	33° 12.9'	30° 42.8'	2 11 21 37 50 67 88 100 105 110 120 132 200 300
12-Oct	20	14:25	32° 29.4'	31° 42.6'	2 22 39 53 69 80 91 95 100 137 200 300
13-Oct	21	06:01	30° 28.3'	33° 57.1'	2 14 27 48 65 86 100 110 113 120 130 170 200 300
13-Oct	23	14:24	29° 40.2'	34° 50.0'	2 14 27 49 66 87 110 115 125 172 200 300
14-Oct	24	05:58	27° 37.9'	32° 1.8'	2 19 31 55 74 98 110 115 120 129 140 193 240 300
15-Oct	27	06:02	24° 44.7'	40° 5.3'	2 14 27 49 66 87 90 100 110 115 120 172 200 300
15-Oct	30	15:02	24° 44.3'	40° 4.2'	2 14 27 49 66 87 100 115 120 140 172 200 300
16-Oct	31	06:01	22° 36.0'	40° 15.9'	2 16 30 53 72 95 110 120 124 130 150 187 200 300
16-Oct	33	14:15	21° 40.4'	39° 35.8'	2 16 30 53 72 95 98 110 124 187 200 300
17-Oct	34	06:00	19° 43.3'	38° 13.8'	2 15 28 49 66 88 100 105 110 115 120 173 200 300
17-Oct	36	14:32	18° 47.3'	37° 34.7'	2 15 28 49 66 88 110 115 120 140 173 200 300
18-Oct	37	06:04	16° 48.6'	36° 12.4'	2 13 24 43 58 76 78 80 85 90 100 150 200 300
18-Oct	40	15:02	16° 48.7'	36° 12.2'	2 13 24 43 58 76 90 100 110 120 150 200 300
19-Oct	41	06:01	14° 55.2'	34° 55.3'	2 11 21 37 42 50 55 60 66 87 100 130 150 200 300
19-Oct	43	14:30	14° 5.6'	34° 21.6'	2 11 21 37 44 48 50 66 87 100 130 200 300
20-Oct	44	06:01	11° 49.2'	32° 49.4'	2 8 15 27 37 39 42 49 52 64 96 120 200 300
20-Oct	46	14:27	10° 53.5'	32° 12.4'	2 8 15 27 37 45 49 52 64 70 96 200 300
21-Oct	47	05:55	8° 38.6'	30° 42.5'	2 9 16 28 38 50 58 66 70 98 120 200 300
21-Oct	49	14:20	7° 39.8'	30° 3.6'	2 9 16 28 38 50 58 62 66 70 99 200 300
22-Oct	50	05:58	5° 20.4'	28° 31.3'	2 10 19 34 46 60 64 68 72 75 79 118 200 300
22-Oct	54	14:30	5° 8.3'	28° 23.5'	2 10 19 34 46 60 65 79 85 90 118 200 300
23-Oct	55	05:58	2° 47.5'	26°	2 10 19 34 46 60 65 70 74 79 90 119 200 300

				51.2'	
23-Oct	57	14:22	1° 49.8'	26° 12.9'	2 10 19 34 46 60 75 79 85 119 200 300
24-Oct	58	05:59	-0° 35.1'	24° 59.8'	2 13 24 43 55 58 76 80 90 100 120 150 200 300
24-Oct	60	13:58	-1° 37.8'	24° 59.6'	2 13 24 43 58 72 76 82 90 100 150 200 300
25-Oct	61	14:34	-6° 3.2'	24° 58.6'	2 12 21 37 50 66 82 87 90 95 130 200 300
26-Oct	62	05:57	-8° 49.5'	24° 59.7'	2 14 25 45 60 80 87 92 95 105 120 157 200 300
26-Oct	64	14:23	-9° 58.5'	25° 0.0'	2 14 25 45 60 80 90 95 105 120 157 200 300
27-Oct	65	06:00	-12° 50.4'	24° 59.9'	2 14 25 45 60 80 105 118 125 130 140 157 200 300
27-Oct	67	14:21	-13° 59.7'	24° 59.7'	2 14 25 45 60 80 105 135 145 150 157 200 300
28-Oct	69	05:59	-16° 38.3'	24° 59.6'	2 18 32 58 78 103 120 135 140 150 160 203 250 300
28-Oct	72	14:24	-16° 52.5'	24° 59.8'	2 18 32 58 78 103 135 145 150 155 203 250 300
29-Oct	74	05:59	-19° 7.4'	24° 59.8'	2 16 30 53 72 95 125 150 170 175 180 187 240 300
29-Oct	76	14:23	-20° 17.0'	25° 0.0'	2 16 30 53 72 95 125 150 160 170 187 220 300
30-Oct	78	06:05	-22° 47.1'	25° 0.5'	2 16 30 53 72 95 125 130 140 145 150 187 220 300
30-Oct	80	14:20	-23° 56.1'	24° 60.0'	2 16 30 53 72 95 125 135 140 150 187 220 300
31-Oct	82	06:00	-26° 33.4'	24° 59.9'	2 17 31 55 74 97 115 120 124 128 135 192 220 300
31-Oct	85	14:40	-26° 43.3'	24° 59.9'	2 17 31 55 74 97 115 120 128 140 192 240 300
01-Nov	86	05:58	-28° 52.1'	26° 2.2'	2 14 26 47 63 84 100 105 110 115 120 165 200 300
02-Nov	88	15:32	-32° 10.8'	29° 49.5'	2 13 25 45 61 80 85 90 95 105 158 250 300
03-Nov	90	07:04	-33° 46.1'	32° 0.2'	2 9 17 30 41 46 50 54 60 64 71 106 200 300
03-Nov	92	15:34	-34° 33.2'	32° 58.8'	2 9 17 30 41 54 71 75 80 85 106 200 300
04-Nov	93	06:03	-36° 10.4'	35° 3.3'	2 8 15 27 37 49 65 90 94 98 110 120 200 300
04-Nov	95	15:26	-36° 10.4'	35° 3.3'	2 8 15 27 37 49 65 90 95 98 110 200 300
05-Nov	96	05:58	-37° 58.1'	37° 24.8'	2 6 12 21 29 38 45 50 60 65 76 100 200 300
05-Nov	98	15:13	-38° 45.9'	38° 27.8'	2 6 12 21 29 38 50 60 76 80 100 200 300
06-Nov	99	15:17	-41° 28.5'	42° 8.7'	2 6 12 21 28 34 38 44 49 74 200 300
07-Nov	100	06:02	-43° 13.6'	44° 36.8'	2 6 11 15 20 26 32 39 50 80 100 200 300
07-Nov	102	15:07	-43° 56.7'	45° 38.9'	2 7 14 25 34 40 45 50 59 88 200 300

1.2. Sample collection for quantification of phytoplankton pigments and micosporine-like amino acids using High Performance Liquid Chromatography (HPLC). *AMT core measurement*

Fresh seawater samples from 6 light depths (97, 55, 33, 14, 3 and 1% of surface light. 1% was sometimes substituted with deep chlorophyll maximum (DCM)) were collected into 7 L polypropylene carboys covered in black plastic to keep out light. Duplicate 1-4 L samples were decanted into rinsed poly propylene bottles with siphon tubes and inverted into a 6 port vacuum filtration rig at a vacuum of 18-20 inches of mercury. Samples were filtered through

25 mm Advantec® GF75 glass fibre filters and the resulting sample filters were folded into 2 mL opaque brown cryovials (Starlab®), flash frozen in liquid nitrogen and stored at -80°C.

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

Table 1.2: CTD casts sampled for phytoplankton pigments and MAAs* (*97% light only)

DATE	CTD	TIME on deck (GMT)	Lat (N, -S)	Long W	Depths sampled (m)	Corresponding % light or DCM
06-Oct	4	14:00	49° 22.3'	11° 23.4'	2 10 20 25 28 40	97 55 33 14 3 DCM
07-Oct	5	05:10	49° 9.0'	14° 39.1'	2 6 12 21 37 49	97 55 33 14 3 1
07-Oct	7	13:40	48° 52.4'	16° 11.8'	2	97
08-Oct	8	05:10	46° 33.4'	18° 41.8'	2 7 1 23 41 54	97 55 33 14 3 1
09-Oct	11	05:00	42° 40.3'	22° 11.7'	2 12 22 40 72 95	97 55 33 14 3 1
10-Oct	13	04:58	38° 40.3'	25° 19.5'	2 24 43 60 78 102	97 33 14 7 3 1
11-Oct	15	06:10	36° 52.9'	27° 44.2'	2 30 50 74 98 129	97 33 14 7 3 1
11-Oct	17	14:22	38° 18.9'	28° 28.2'	2	97
12-Oct	18	06:01	33° 12.9'	30° 42.8'	2 21 37 50 67 110	97 55 33 14 3 DCM
12-Oct	20	14:25	32° 29.4'	31° 42.6'	2	97
13-Oct	21	06:01	30° 28.3'	33° 57.1'	2 27 48 65 86 120	97 55 33 14 3 DCM
13-Oct	23	14:24	29° 40.2'	34° 50.0'	2	97
14-Oct	24	05:58	27° 37.9'	32° 1.8'	2 31 55 74 98 120	97 55 33 14 3 DCM
15-Oct	27	06:02	24° 44.7'	40° 5.3'	2 27 49 66 87 115	97 33 14 7 3 1
15-Oct	30	15:02	24° 44.3'	40° 4.2'	2	97
16-Oct	31	06:01	22° 36.0'	40° 15.9'	2 30 53 72 95 124	97 33 14 7 3 1
16-Oct	33	14:15	21° 40.4'	39° 35.8'	2	97
17-Oct	34	06:00	19° 43.3'	38° 13.8'	2 28 49 66 88 110	97 33 14 7 3 1
17-Oct	36	14:32	18° 47.3'	37° 34.7'	2	97
18-Oct	37	06:04	16° 48.6'	36° 12.4'	2 24 43 58 76 100	97 33 14 7 3 1
18-Oct	40	15:02	16° 48.7'	36° 12.2'	2	97
19-Oct	41	06:01	14° 55.2'	34° 55.3'	2 21 37 50 66 87	97 33 14 7 3 1
19-Oct	43	14:30	14° 5.6'	34° 21.6'	2	97
20-Oct	44	06:01	11° 49.2'	32° 49.4'	2 15 27 37 49 64	97 33 14 7 3 1
20-Oct	46	14:27	10° 53.5'	32° 12.4'	2	97
21-Oct	47	05:55	8° 38.6'	30° 42.5'	2 09 16 38 50 66	97 55 33 7 3 1
21-Oct	49	14:20	7° 39.8'	30° 3.6'	2	97
22-Oct	50	05:58	5° 20.4'	28° 31.3'	2 19 34 46 60 79	97 33 14 7 3 1
22-Oct	54	14:30	5° 8.3'	28° 23.5'	2	97
23-Oct	55	05:58	2° 47.5'	26° 51.2'	2 19 34 46 60 70	97 33 14 7 3 DCM
23-Oct	57	14:22	1° 49.8'	26° 12.9'	2	97
24-Oct	58	05:59	-0° 35.1'	24° 59.8'	2 24 43 58 76 100	97 33 14 7 3 1
24-Oct	60	13:58	-1° 37.8'	24° 59.6'	2	97
25-Oct	61	14:34	-6° 3.2'	24° 58.6'	2	97
26-Oct	62	05:57	-8° 49.5'	24° 59.7'	2 25 45 60 80 105	97 33 14 7 3 1
26-Oct	64	14:23	-9° 58.5'	25° 0.0'	2	97
27-Oct	65	06:00	-12° 50.4'	24° 59.9'	2 25 45 60 80 130	97 33 14 7 3 DCM
27-Oct	67	14:21	-13° 59.7'	24° 59.7'	2	97
28-Oct	69	05:59	-16° 38.3'	24° 59.6'	2 32 58 78 103 145	97 33 14 7 3 1
28-Oct	72	14:24	-16° 52.5'	24° 59.8'	2	97 (no MAAs)
29-Oct	74	05:59	-19° 7.4'	24° 59.8'	2 30 53 72 95 175	97 33 14 7 3 DCM
29-Oct	76	14:23	-20° 17.0'	25° 0.0'	2	97
30-Oct	78	06:05	-22° 47.1'	25° 0.5'	2 30 53 72 95 140	97 33 14 7 3 DCM
30-Oct	80	14:20	-23° 56.1'	24° 60.0'	2	97

31-Oct	82	06:00	-26° 33.4'	24° 59.9'	2 31 55 74 97 128	97 33 14 7 3 1
31-Oct	85	14:40	-26° 43.3'	24° 59.9'	2	97
01-Nov	86	05:58	-28° 52.1'	26° 2.2'	2 26 47 63 84 110	97 33 14 7 3 1
02-Nov	88	15:32	-32° 10.8'	29° 49.5'	2	97
03-Nov	90	07:04	-33° 46.1'	32° 0.2'	2 9 30 41 54 71	97 55 14 7 3 1
03-Nov	92	15:34	-34° 33.2'	32° 58.8'	2	97
04-Nov	93	06:03	-36° 10.4'	35° 3.3'	2 8 27 37 49 65	97 55 14 7 3 1
04-Nov	95	15:26	-36° 10.4'	35° 3.3'	2	97
05-Nov	96	05:58	-37° 58.1'	37° 24.8'	2 6 21 29 38 50	97 55 14 7 3 1
05-Nov	98	15:13	-38° 45.9'	38° 27.8'	2	97
06-Nov	99	15:17	-41° 28.5'	42° 8.7'	2	97
07-Nov	100	06:02	-43° 13.6'	44° 36.8'	2 6 11 15 20 26	97 33 14 7 3 1
07-Nov	102	15:07	-43° 56.7'	45° 38.9'	2	97

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

A newly developed microplankton net containing a series of 3 conical nets with mesh sizes 180, 100 and 40 µm was deployed from the forward crane at the same time as solar noon CTDs on a regular basis through the northern and southern subtropical gyres, equatorial upwelling region and south Atlantic subtropical convergence zone. At each site, duplicate plankton samples were collected on vertical net hauls from 50 m to the surface. 40-100 µm and 100-180 µm fractions were collected in their respective cod ends and then analysed on a FlowCAM (Fluid Imaging inc.) with a 300 µm path length flow cell, a 4x microscope objective and a CCD camera operating in trigger mode at a frame grab rate of 7 frames per second. Data files were stored on the FlowCAM computer's hard drive and will be analysed back in the lab. to provide community composition data in the different water masses along the cruise transect. Table GT3 summarises the dates and times of net hauls.

Table 1.3: Summary of net hauls for microplankton community structure

DATE	Associated with CTD	TIME on deck (GMT)	Lat (N, -S)	Long W
11-Oct	17	14:13	38° 18.9'	28° 28.2'
12-Oct	20	14:02	32° 29.4'	31° 42.6'
13-Oct	23	13:49	29° 40.2'	34° 50.0'
21-Oct	49	13:59	7° 39.8'	30° 3.6'
22-Oct	54	14:03	5° 8.3'	28° 23.5'
23-Oct	57	13:55	1° 49.8'	26° 12.9'
25-Oct	61	14:07	-6° 3.2'	24° 58.6'
27-Oct	67	13:56	-13° 59.7'	24° 59.7'
28-Oct	69	05:59	-16° 52.5'	24° 59.8'
29-Oct	76	13:58	-20° 17.0'	25° 0.0'
31-Oct	85	14:21	-26° 43.3'	24° 59.9'
02-Nov	88	15:11	-32° 10.8'	29° 49.5'
03-Nov	92	15:09	-34° 33.2'	32° 58.8'
04-Nov	95	14:59	-36° 10.4'	35° 3.3'
05-Nov	98	14:50	-37° 58.1'	37° 24.8'
06-Nov	99	14:52	-41° 28.5'	42° 8.7'

2. Factors Affecting Community Structure of Marine Picocyanobacteria (Ostrowski, Pearman)

Objectives

- To determine the horizontal and vertical distribution of genetically distinct populations of ***Prochlorococcus (Pro), Synechococcus (Syn),*** pico- and nano-eukaryotes (Peuk)***.***
- Isolation of Syn, Pro and Peuk cultures with the aid of flow-sorting.
- Metagenomics and transcriptomics of flow-sorted Syn and Peuk populations at selected stations
- Concentration of biomass samples for elemental composition analysis of flow-sorted ***Syn, Pro*** and ***Peuk*** cells using X-Ray TEM and High Resolution Inductively-Coupled-Plasma Mass Spectrometry (HR ICP-MS)
- Phage: samples and experiments

2.1. Distribution of *Pro, Syn* and Peuk

2.1a. Sampling strategy

Bulk community DNA was collected at the 2nd pre-dawn CTD from 6 light depths (97, 55, 14, 7, 1 and 0.1%) (Table 2.1). Up to 12 l vol from each depth was pre-filtered through 100 µm mesh and 10.0 µm polycarbonate (PC) filters while the 5.0µm (PC) and 0.45 µm (Supor) fractions were retained and flash frozen (liq. N_2) in 3.0 ml of lysis buffer and stored at -80˚C. Additionally, 500 ml samples from 2 depths were fixed with PFA (0.1%w/v, 1h, 4˚C) and concentrated by gentle vacuum filtration onto 0.2 µm membranes and stirred at -80˚C for analysis by Fluorescence ***in-situ*** Hybridisation (FISH) with lineage-specific probes for ***Syn, Pro*** and Peuk.

2.1b. Proposed analyses

DNA will be extracted from filters using established techniques and analysed by a variety of methods in the laboratory. Semi-quantitative estimates of the abundance of up to 6 ribotypes of ***Pro***, 16 ribotypes of ***Syn*** and more than 10 plastidic ribotypes for Peuks will be obtained using dotblots with ^{32}P labelled probes. Supporting analyses include construction of clone libraries for 16S ribosomal RNA and internal transcribed spacer (ITS) regions, clone libraries and (t)RFLP analyses of MLSA marker genes (such as ***petB***). Estimates of species/ribotype abundance will complement the flow cytometric analsyses of underway and CTD samples (Tarran/Holland) as well as allow for direct comparison with similar data obtained on AMT-15 (Zwirglmaier et al., 2008) and AMT-13 (Johnson et al., 2006). A total of 32 stations were sampled for a total volume of 1,920 l of seawater filtered.

Table 2.1a: Summary of size-fractionated bulk DNA samples. Samples were concentrated from 5.0 -10.0 l of seawater and pre-filtered through 100 µm mesh and 10.0 µm filters. Concentrated samples were retained on 5.0 and 0.45 µm filters and flash frozen.

cryo-box	cast	CTD	date	lat˚N	lon˚W	depths (m)	notes
UWAR1	pre-dawn-2	JR218_003	6-Oct	49˚28.96	9˚50.83	surf, 10, 25, 35, 60, 100	no light depth calibration
UWAR1	pre-dawn-2	JR218_006	7-Oct	49˚8.96	14˚39.15	surf, 6, 12, 21, 49, 73	
UWAR1	pre-dawn-2	JR218_009	8-Oct	46˚35.44	18˚41.80	surf, 7, 13, 23, 54, 81	
UWAR1	pre-dawn-2	JR218_012	9-Oct	42˚40.38	22˚11.70	surf, 12, *22, 40, 95, 143	
UWAR2	pre-dawn-2	JR218_014	10-Oct	38˚52.91	25˚19.46	surf, 13, 24, 43, 102, 154	
UWAR2	pre-dawn-2	JR218_016	11-Oct	36˚0.70	27˚44.24	surf, 16, 55, 74, 129, 193	
UWAR2	pre-dawn-2	JR218_019	12-Oct	33˚17.87	30˚47.82	surf, 11, 37, 50, 88, 132	
UWAR2	pre-dawn-2	JR218_022	13-Oct	30˚28.34	33˚57.07	surf, 14, 48, 65, 113, 120	
UWAR3	pre-dawn-2	JR218_025	14-Oct	27˚37.90	37˚1.83	surf, 19!, 55, 74, 129, 193	not enough water for dot blot filter (I.e the 55 sample went to metagenomics)

cryo-box	cast	CTD	date	lat˚N	lon˚W	depths (m)	notes
UWAR3	pre-dawn-2	JR218_028	15-Oct	24˚44.66	40˚5.30	surf, 12, 49, 66, 115, 172	
UWAR3	pre-dawn-2	JR218_032	16-Oct	22˚35.99	40˚15.95	surf, 16, 53, 72, 124, 187	
UWAR3	pre-dawn-2	JR218_035	17-Oct	19˚43.35	38˚13.81	surf, 15, 49, 66, 115, 173	
UWAR4	pre-dawn-2	JR218_038	18-Oct	16˚48.64	36˚12.40	surf, 13, 43, 58, 100, 150	
UWAR4	pre-dawn-2	JR218_042	19-Oct	14˚55.16	34˚55.32	surf, 11, 37, 50, 87, 130	
UWAR4	pre-dawn-2	JR218_045	20-Oct	11˚49.24	32˚49.45	surf, 8, 27, 37, 64, 96	
UWAR4	pre-dawn-2	JR218_048	21-Nov	8˚38.63	30˚42.50	surf, 9, 28, 38, 66, 98	
UWAR5	pre-dawn-2	JR218_051	22-Oct	5˚20.38	28˚31.28	surf, 10, 34, 46, 79, 118	
UWAR5	pre-dawn-2	JR218_056	23-Oct	2˚47.55	26˚51.28	surf, 10, 34, 46, 79, 119	
UWAR5	pre-dawn-2	JR218_059	24-Oct	-0˚34.76	24˚59.64	surf, 13, 43, 58, 100, 150	
UWAR5	pre-dawn-2	JR218_063	26-Oct	-8˚49.52	24˚59.72	surf, 14, 45, 60, 104, 157	
UWAR6	pre-dawn-2	JR218_066	27-Oct	-12˚50.38	24˚59.89	surf, 14, 45, 60, 105, 157	
UWAR6	pre-dawn-2	JR218_070	28-Oct	-16˚38.26	24˚59.63	surf, 18, 58, 78, 135, 203	
UWAR6	pre-dawn-2	JR218_075	29-Oct	-19˚7.42	25˚59.75	surf, 16, 53, 72, 125, 187	
UWAR6	pre-dawn-2	JR218_079	30-Oct	-22˚47.13	25˚0.55	surf, 16, 53, 72, 125, 187	
UWAR7	pre-dawn-2	JR218_083	31-Oct	-26˚33.43	24˚59.87	surf, 17, 55, 74, 128, 192	
UWAR7	pre-dawn-2	JR218_087	1-Nov	-28˚52.10	26˚2.17	surf, 14, 47, 63, 110, 165	cell trap for tests (RNA etc. 20L)
UWAR7	pre-dawn-2	JR218_091	3-Nov	-33˚46.09	32˚0.19	surf, 9, 30, 41, 71, 100	filters full of bubbles, diatom bloom observed in netting
UWAR8	pre-dawn-2	JR218_097	5-Nov	-37˚57.80	37˚24.24	surf, 6, 21, 29, 50, 76	
UWAR8	pre-dawn-2	JR218_101	7-Nov	-43˚13.60	44˚36.81	surf, 3, 11, 15, 26, 39	

Table 2.1b: Summary of size-fractionated samples for FISH. Samples were concentrated from 500 ml of seawater after PFA fixation.

CTD	Date	Depths (m)	notes
JR218-003	6th October	Surf, 35, 60	
JR218-006	7th October	Surf, 49	
JR218-009	8th October	7, 54	
JR218-012	9th October	Surf, 95	
JR218-014	10th October	Surf, 102	
JR218_016	11th October	Surf, 90, 124	
JR218_019	12th October	Surf, 110, 132	
JR218_022	13th October	Surf, 113, 120	
JR218_025	14th October	Surf, 129	
JR218_028	15th October	Surf, 115	
JR218_032	16th October	Surf, 124	
JR218_035	17th October	Surf, 115	
JR218_038	18th October	Surf, 100	
JR218_042	19th October		
JR218_045	20th October	Surf, 64	
JR218_048	21st October	Surf, 66	

CTD	Date	Depths (m)	notes
JR218_051	22nd October	Surf, 79	
JR218_056	23rd October	Surf, 79	
JR218_059	24th October	Surf, 100	
JR218_061	25th October	Surf, 87	Afternoon
JR218_063	26th October	Surf, 92, 104	
JR218_066	27th October	Surf, 105	
JR218_070	28th October	Surf, 135	
JR218_075	29th October	Surf, 125	
JR218_079	30th October	Surf, 125, 130	
JR218_083	31st October	Surf, 115	
JR218_086	1st November	Surf, 110	
JR218_088	2nd November	Surf, 105	
JR218_091	3rd November	Surf, 71	
JR218_094	4th November	Surf, 65	
JR218_097	5th November		
JR218_099	6th November	Surf	Afternoon
JR218_101	7th November	Surf, 26	

2.2. Isolation of Syn, Pro and Peuk cultures with the aid of flow-sorting

2.2a. Sampling strategy

Enrichment cultures and flow-sorting (FACSort) were used on most days to isolate Syn and Peuk cultures. Generally, seawater from surface (97%) and deep (0.1% light depth) samples were pre-concentrated (~ 5-10 X) using 0.2 µm polycarbonate anodisc filters. The concentrates were used to either inoculate selective media (K-medium for Peuk and Pro99 with NH_4 or NO_3 additions for Syn/Pro) or sorted using the FACSort into pre-filtered deep water (0.2 µm filtered water from 200 or 300 m). When multiple distinct populations were observed on cytograms the sub-populations were sorted separately. Sheath fluid was prepared by filtration of deep water (200 or 300 m) through at least a 0.2 µm sterivex filter or similar pre-cooled to < 20℃ on warm days. Sorted samples often contained between 1,000 and 20,000 cells sorted into a combined volume of sheath fluid up to 10 ml. Cultures were incubated on a constant light or light-dark cycle at 20-26℃ at a variety of cool-white fluorescent light intensities.

2.2b. Preliminary results

Pigmented cultures were obtained for ***Synechococcus*** enrichments and cell-sorted samples from 31 stations.

Cell sorted samples from 39 stations were obtained for picoeukaryotes. 32 samples of concentrated seawater were also collected for further sorting in the lab alongside Fluorescent in situ hybridization work to identify interesting groups.

2.3. Metagenomics and transcriptomics of Syn and Peuk populations at selected stations

2.3a. Sampling strategy

Seawater was collected from 2 depths at 9 stations in the oligotrophic Northern and Southern gyres, the equatorial region and at the high-latitude temperate extremities of the cruise (Table 2.2.). Seawater concentrates were collected in Cell Traps (0.22 µm) after size-fractionation (100 µm mesh, 10 µm and 5.0 µm PC filter membranes).

2.3b. Proposed analyses

DNA and RNA will be extracted from flow-sorted populations of Syn, Pro and Peuk and amplified using a commercial kit (after reverse transcription for RNA). Amplified nucleic acids will then be sequenced to a high depth-of coverage using 454 sequencing at a NERC Molecular Genetics Facilty.

Table 2.2: Summary of size-fractionated samples for metagenomics and meta-transcriptomics work. Samples were concentrated from 20 l of seawater in duplicate and pre-filtered through 100 µm mesh and 10.0 µm filters. Concentrated samples were extracted in triplicate from 0.22 µm cell traps. The initial concentrates, corresponding to 3-4 l of seawater, were extracted within 30 min.

cryo-box	cast	CTD	date	lat °N	lon °W	depths (m)	notes
UWAR24	pre-dawn-2	JR218_006	7-Oct	49 8.96	14 39.15	6, 49	
UWAR24	pre-dawn-2	JR218_012	9-Oct	42 40.38	22 11.70	12, 95	
UWAR24	pre-dawn-2	JR218_025	14-Oct	27 37.90	37 1.83	19, 120	
UWAR24	pre-dawn-2	JR218_028	15-Oct	24 44.66	40 5.30	12, 115	
UWAR24	pre-dawn-2	JR218_056	23-Oct	2 47.55	26 51.28	10, 70	
UWAR24	pre-dawn-2	JR218_070	28-Oct	-16 38.26	24 59.63	18, 150	
UWAR24	pre-dawn-2	JR218_083	31-Oct	-26 33.43	24 59.87	17, 115	
UWAR24	pre-dawn-2	JR218_091	3-Nov	-33 46.09	32 0.19	9, dcm	filters full of bubbles, possible diatom bloom as seen in the netting.
UWAR24	pre-dawn-2	JR218_101	7-Nov	-43 13.60	44 36.81	3, 26	

2.4. Elemental composition analysis of flow-sorted *Syn, Pro* and *Peuk* cells using X-Ray TEM and High Resolution Inductively-Coupled-Plasma Mass Spectrometry (HR ICP-MS)

2.4a. Sampling strategy

Seawater was collected from up to 4 depths at 24 stations along the transect at the noon CTD. Up to 10 l was collected in acid-washed polycarbonate carboys shrouded in light-proof plastic and immediately processed. Seawater samples were pre-filtered (100 µm mesh and 10.0 µm PC) and the < 3.0 µm fraction was concentrated in Cell Traps (0.22 µm pore size). All filter-holders, filters and peristaltic pump tubing was saoked in 5% trace-clean HCl, rinsed with MilliQ and pre-wahsed with ~ 500 ml of seawater sample. Concentrated cells were extracted at least three times from each trap with the first extraction, corresponding to 3-5 l of seawater, after 30-45 min of concentration. Concentrated cells were immediately flash frozen in Liq. N_2 and transferred to -80℃.

2.4b. Proposed analyses

Micro-elemental composition (S, P, Fe, Zn, Co, Cu, Mo) of flow-sorted Syn, Pro (and Peuk where possible) as well as bulk samples will be determined with an Agilent 7500cx HR-ICPMS instrument equiped with an octopole reaction system (ORS). For the trace metals to be tested the instrument has limits of detection in the low ppb to ppt range, as verified by trace-metal controlled pre-cruise optimisation trials carried out with cyanobacterial cultures. To complement this analysis we will also determine the composition of ‘macro’ elements (C, N, P, Na, Mg, K, Cl), as well as Fe and other trace metals, in single picocyanobacterial cells using XRay-TEM. This work will provide fundamental knowledge on the trace-metal physiology of members of the picocyanobacterial genera, ***Synechococccus*** and ***Prochlorococcus*** and link directly to data obtained from the assessment of community structure (outlined in section 2.1).

Table 2.3: Summary for elemental composition analysis samples. Replicate samples were concentrated from up to 10l of seawater from 4 light-depths (97%, 55%, 1.0% and 0.1%), and flash frozen in 1.6 ml aliquots.

cryo-box	cast	CTD	date	lat˚N	lon˚W	depths (m)	notes
UWAR21	noon	JR218_004	6-Oct	49˚22.31	11˚23.44	10, 40	
UWAR21	noon	JR218_007	7-Oct	48˚52.05	16˚11.65	surf, 49	
UWAR21	noon	JR218_010	8-Oct	45˚39.85	19˚35.22	8, 65	
UWAR21	noon	JR218_017	11-Oct	35˚18.8241	28˚27.9797	surf, 25, 44, 156	
UWAR21	noon	JR218_020	12-Oct	32˚29.40	31˚42.60	surf, 22, 39, 157	
UWAR21	noon	JR218_030	15-Oct	24˚44.29	40˚04.20	surf, 27, 115, 172	changed sampling to 97%, 55%, 1.0%, 0.1%
UWAR21	noon	JR218_033	16-Oct	21˚40.40	39˚35.78	surf, 30, 124, 187	
UWAR21	noon	JR218_040	18-Oct	16˚48.64	36˚12.40	surf, 24, 100, 150	
UWAR22	noon	JR218_043	19-Oct	14˚05.597	34˚21.605	surf, 21, 87, 130	
UWAR22	noon	JR218_046	20-Oct	10˚53.50	32˚12.38	surf, 8, 64, 96	
UWAR22	noon	JR218_049	21-Nov	07˚39.76	30˚03.56	surf, 16, 66, 99	flow cam shows plenty of trichodesmium from netting
UWAR22	noon	JR218_057	23-Oct	01˚49.83N	026˚12.92	surf, 10, 79, 119	
UWAR22	noon	JR218_060	24-Oct	01˚37.75	024˚59.69	13, 100,	only 2 samples
UWAR22	noon	JR218_061	25-Oct	-06˚03.14	024˚58.63	surf, 21, 87, 130	
UWAR22	noon	JR218_064	26-Oct	-09˚58.52	024˚59.96	surf, 14, 105, 157	fresh pp tubes (Fisherbrand)
UWAR22	noon	JR218_067	27-Oct	-13˚59.71	024˚59.71	surf,14, 105, 157	
UWAR22	evening	JR218_068	27-Oct	-14˚59.60	024˚59.66	20m,	protein cell trap good yield x 2
UWAR22	noon	JR218_072	28-Oct	-16˚52.52	024˚59.77	surf, 33, 135, 203	
UWAR22	noon	JR218_076	29-Oct	-20˚16.99	25˚00.07	surf, 30, 125, 187	
UWAR23	noon	JR218_080	30-Oct	-23˚56.07	24˚59.96	surf, 16, 125, 187	
UWAR23	noon	JR218_085	31-Oct	-26˚43.33	24˚59.87	surf, 31, 128, 192	
UWAR23	noon	JR218_088	2-Nov	-32˚10.77	29˚49.53	surf, 25, 105, 158	1st extract at 50 min
UWAR23	noon	JR218_095	4-Nov	-36˚10.38	35˚03.25	surf, 15, 65, 98	good yield for 2 samples each
UWAR23	noon	JR218_098	5-Nov	-38˚45.73	38˚27.53	surf, 12, 50, 76	
UWAR23	noon	JR218_099	6-Nov	-41˚28.611	42˚08.369	surf, 12, 49*, 74	another diatom bloom, gelatinous brown stuff, 100µ mesh clogged, low yield in cell trap

2.5. Phage samples and lysogeny experiments

Samples were taken from three sites along the transect, with the northern and southern gyres as well as the equatorial region represented. The aim of the experiment was to enumerate the percentage of ***Synechococcus*** affected by phage in the natural environment. To achieve this, samples were incubated with Mitomycin C to induce lysogeny over a 24 hr period. Sub-samples were taken every 6 hours and filtered onto both 0.2 and 0.02µm filters. These samples would then be compared with a negative control (seawater taken at the same time without the addition of Mitomycin C) and used to assess the proportion of Syn cells which were infected by phage. A small amount of water was stored at 4 degrees every 6

hours so the total number of cyanophage could be assessed. Samples were filtered every other day onto a 0.2µm filter in order that RING-FISH can be undertaken to assess the number of infected cells as well as doing TSA_FISH to calculate the number of Syns and Pros present in the sample.

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

Aim: To examine phylogenetic composition as well as metabolic activities of dominant microbial groups within planktonic communities in the oligotrophic North Atlantic gyre and South Atlantic gyre. To assess rates of carbon fixation by microbial groups and to determine the contribution of each group to total carbon fixation.

Objectives

- To estimate turnover rates of dissolved organic nutrients and phosphorus using methionine, leucine, ATP and phosphate tracers.
- To estimate carbon fixation rates of dominant phototrophic microbes.
- To collect concentrated seawater samples for molecular analysis of the phylogenetic composition of the groups (flow sorted for rate measurements) using clone libraries and fluorescence ***in situ*** hybridisation (FISH).

3.1. Estimations of turnover rates of dissolved organic nutrients and bioavailable phophate

Ambient concentrations as well as uptake rates of the amino acids (leucine and methionine), phosphate and ATP by total bacterioplankton were measured using isotopic dilution time-series incubations (Zubkov et al., 2004; Zubkov et al., 2007). Microbial phosphorus dymanics were determined in the phosphate-depleted North Atlantic gyre (Table 3.1. stations marked with a star) to estimate ambient concentrations and turnover rates of the bioavailable fraction of these nutrients. All seawater samples were processed within an hour of collection. In addition, the relative contributions by dominant groups of microorganisms to the amino acid and phosphate cycle were determined using flow cytometric cell sorting.

Table 3.1: Sampling stations including CTD no., dates, bottle no. and depth. At stations marked with a * ambient concentrations of bioavailable phosphate were determined.

CTD no.	Date	Bottle no.	Depth [m]
10	08.10.08	13	27
12	09.10.08	22	surf
14*	10.10.08	22	surf
16*	11.10.08	16	30
18*	12.10.08	11	21
21*	13.10.08	24	27
24*	14.10.08	24	19
27*	15.10.08	24	27
31*	16.10.08	24	30
34*	17.10.08	24	28
37*	18.10.08	24	24
41*	19.10.08	24	27
44*	20.10.08	24	15
47*	21.10.08	24	28
50*	22.10.08	24	19
55*	23.10.08	24	19
58*	24.10.08	24	24
62*	26.10.08	24	24
65	27.10.08	24	n.d.
68	27.10.08	16	20
69	28.10.08	24	18
73	28.10.08	16	20

74	29.10.08	24	16
77	29.10.08	17	20
78	30.10.08	24	16
81	30.10.08	16	20
82	31.10.08	24	17
86	01.11.08	24	14
88	02.11.08	18	25
90	03.11.08	24	n.d.
93	04.11.08	24	n.d.
96	05.11.08	24	21

3.2. Estimation of carbon fixation rates by dominant microbial groups

Sodium ^{14}C-bicarbonate was used in a series of experiments to trace photosynthetic fixation by microbes. In addition, the relative contributions by dominant groups of microorganisms to the carbon cycle were determined using flow cytometric cell sorting. Seawater samples were incubated for 12h, subsequently fixed with paraformaldehyde (PFA, 1% final concentration) and filtered on 0.2µm pore size polycarbonate filter to determine total carbon uptake.

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

In order to understand the contribution of photosynthetic picoeukaryotes (PPEs) to carbon fluxes and the microbial food web, it is necessary to quantify the dominating phylogenetic groups within that cluster. Clone libraries will be constructed using eukarotic 18S rDNA primer pairs as well as prokaryotic 16S rDNA primer pairs targeting specifically chloroplastidic DNA of photosynthetic eukaryotes. This approach will be combined with TSA-FISH to assess the distribution, the abundance and the contribution of specific PPE classes to the total phytoplankton biomass. In addition, the results of the molecular approach will be compared to those of the tracer experiments.

To determine the variation within the PPE classes, samples were collected at 32 stations (Table 3.1). Microbial cells were concentrated from seawater samples of 3L using a 20µm pore-size mesh, to screen out larger organisms, combined with a Celltrap^{TM} ceramic filtration unit. Immediately after this procedure, cells were flash frozen with liquid nitrogen and stored at -80℃.

3.4. Preliminary observations.

Initial scintillation counts were carried out on board the ship (Packard Tri-Carb 3100). Bioassayed concentrations of methionine and leucine ranged between 0.2-1.4 nM and 0.1-1 nM, respectively. The estimated turnover of these amino acid molecules ranged between 10-178 and 2-54 hours, respectively. The bioavailable phosphate concentrations ranged between 0.02-2.6 nM and the estimated turnover time for phosphate varied between 0.6-138 hours. Finally, concentrations of 0.02-2.0 nM and an estimated turnover time of 8-141 hours were measured for ATP. Detailed analysis of the collected tracer samples will be carried out after the cruise on low background counters due to the sensitivity limitations of the scintillation counter on board. Following completion the data set will allow estimation of the rates of bacterioplankton and phytoplankton metabolic activity as well as production and mortality. Furthermore, using the molecular approaches we will be able to link the prokaryotic and eukaryotic phylogenetic composition and function.

Zooplankton Community Size Structure

Chris Gallienne, Plymouth Marine Laboratory

Introduction:

The mesozooplankton sampling programme aboard AMT18 had three principal components. The first was a daily vertical net haul sample processed through the Optical Plankton Recorder (OPC) to give a reliable indication of size-distributed mesozooplankton biomass at each station. The second was a vertical net haul sample preserved in buffered 4% formaldehyde solution for subsequent taxonomic analysis in the laboratory. Thirdly, in the northern gyre section of the cruise, a sample from the daily vertical net haul was similarly preserved at the request of Antje Voelker at the LNEG (Laboratorio Nacional de Energia e Geologia) laboratory in Lisbon, Portugal, to whom it was dispatched after the cruise.

Methods:

Vertical Net hauls were made each day at the pre-dawn station between year days 281 and 312 (7th October to 7th November). A double (bongo) net frame was deployed, with 0.57m diameter openings and carrying 2 WP2 nets with 200µm nylon mesh. Net hauls were from 180m to the surface, and flow was measured through the mouth of the net using a mechanical flow meter, and the volume of sea water sampled for each net cast was calculated.

OPC biomass size distribution:

The OPC (see below) 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 having 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).

The Optical Plankton Counter

Samples stored at PML for taxonomic analysis are currently awaiting resources for this analysis. A summary of the OPC data collected during AMT18 is presented in figures 1 and 2, below.

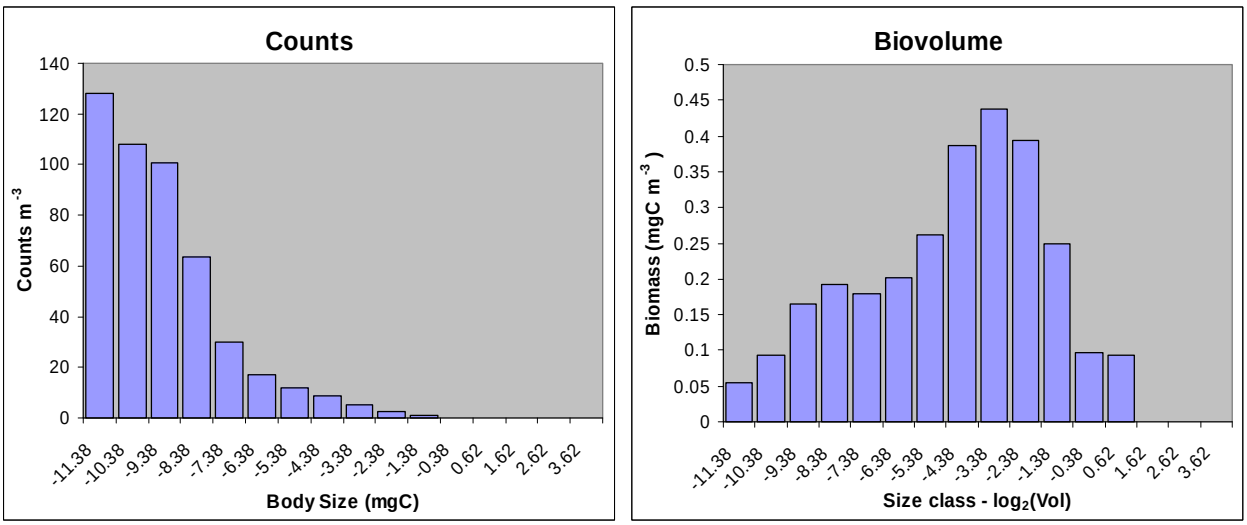

Figure 1: A typical size-distribution of abundance and biomass for a net sample taken on day 294 (20th October).

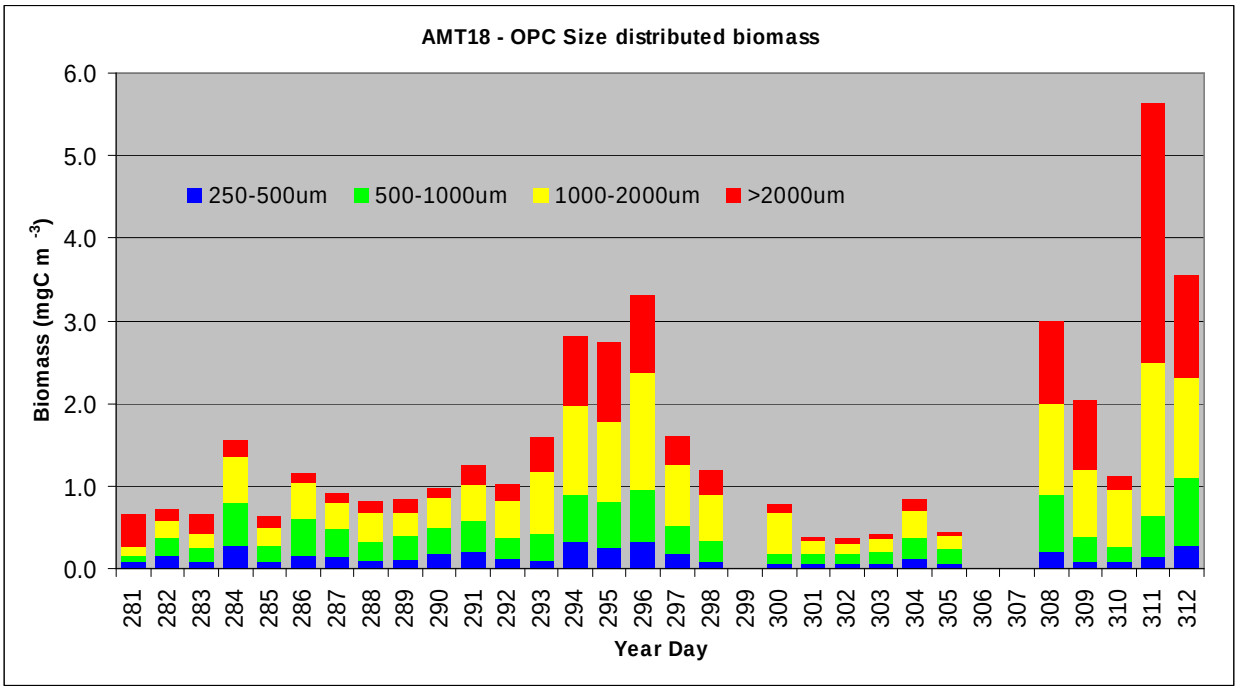

Figure 2: OPC size-distribution of biomass in 4 'JGOFS' size classes for all stations during AMT18.

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Optics Cruise Report

Reporter: Tim Smyth reporting for scientist onboard Chris Gallienne. Contributions (bb6) from Victor Martinez-Vicente

Aims and objectives

Prior to the cruise, and as part of the SOLAS programme, I had been developing a coupled atmospheric in-water UV optical model. The model required measurements of chlorophyll and CDOM to extrapolate the signal measured in the visible (400 – 700 nm) to the UV (300 – 400 nm). On this cruise I hoped to take measurements of spectral inherent optical properties (using an ac-9) with which to better parameterise, and coincidental in-water spectral UV with which to validate the model. The atmospheric component of the model would be validated against the deck measured incident UV measurements.

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

Methodology

In-water optics

On the optics rig the following instruments were deployed: Wet Labs ac-9; Wet Labs flow cells; Fast Repetition Rate Fluorometer (NMF supplied); Satlantic UV sensor; Seabird SBE19+ CTD; Hobilabs hydroscat 6 – also known as bb6 (see appendix for instrument details).

The optics rig was deployed from the starboard aft quarter of the ship using the capston on 180 m of 6 mm dyneema generally at solar noon. Optical protocols state that deployments should be on the sunward side of the ship; this criterion was generally met. The instruments were switched on and the instrument package lowered into the water and kept at the surface for four minutes. The rig was then lowered at a fairly fast rate (0.5 m/s) down to 180 m depth. The upcast is the important part of the deployment and this was carried out at 0.1 m/s.

Upon recovery, data from the instruments was downloaded: hyperterminal was used to download the FRRF; WLHost the ac-9, UV sensor and CTD combination; and Hobilabs software (Hydrosoft 2.72) to download the bb6.

The FRRF data was processed using V6 of the Sam Laney (WHOI) Matlab code. This requires the FRRF to be characterised using 0.2 µm filtered water, at each of the gain settings (0, 1, 4, 16, 64, 256) for both the light and dark chambers, in a black bucket. This was done once at the start of the AMT transect. The primary outputs of the FRRF data stream were the maximum fluorescence (Fm) and the ratio of the variable to maximum fluorescence (Fv/Fm). The final FRRF data product will consist of the phytoplankton physiological parameters binned to 2 m depth resolution.

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

The bb6 data are currently being processed in the laboratory as processing requires a further post-cruise calibration and the processed ac9 data for correction purposes. The data presented here are preliminary only. The backscattering processing is as follows. The upcast is selected and interpolated onto a 0.5 m resolution grid; further processing is then carried out as described in the manual. A sigma correction is applied using the calibration values and an extrapolation from 117° to the whole backward direction is made using Xp = 1.18 (recommended by latest literature). The backscatter due to pure water using Twardowski et al 2007 algorithm (with adjustments for temperature and salinity) is subtracted.

Atmospheric optics

Surface UV measurements

A Trios Rameses ACC UV sensor was setup high on the ship and configured to log hyperspectal UV between 200 and 500 nm at 2.5 nm resolution every 5 minutes through daylight hours. The data can either be kept as hyperspectral (to force e.g. in-water light field models) or integrated over broadband (UV-A and UV-B) ranges (this was done on the cruise using bespoke IDL routines). Unfortunately, after the end of the cruise, it was found that oil had ingressed into the optical head and there was no useable data for the whole transect.

Satlantic Hypersas

A Satlantic HyperSAS system was also mounted high on the ship. The instrument has three sensors measuring: i) sea upwelling radiance (angled at 45 degrees downwards); ii) sky downwelling radiance (angled at 45 degrees upwards) and iii) downwelling radiance (pointing vertically). The data is merged with GPS information and data processing for water leaving reflectance will be carried out back at the laboratory. Data is available for the period until the equator when the system stopped working.

Microtops sun photometer

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

Results

Date (yymmdd)	Time (upcast)	Cast ID	FRRF	Lat	Lon	max depth	Comments
081006	n/a	OPT001	N	49.36441	-11.51897	n/a	instrument failure – no useable data
081007	13:45	OPT002	N	48.86017	-16.1929	187	no useable FRRF
081008	n/a	OPT003	N	45.66357	-19.58628	n/a	instrument failure – no useable data
081011	13:50	OPT004	N	35.31431	-28.46796	177	no useable FRRF
081012	n/a	OPT005	Y	32.49006	-31.7102	n/a	instrument failure – no useable data
081013	n/a	OPT006	Y	29.66968	-34.83354	n/a	instrument failure – no useable data
081014	13:45	OPT007	Y	26.81251	-37.89589	183	no useable ac9
081015	14:20	OPT008	Y	24.73815	-40.07011	175	
081016	13:45	OPT009	Y	21.67322	-39.59642	185	
081017	13:45	OPT010	N	18.78867	-37.57789	185	no FRRF
081018	14:30	OPT011	Y	16.81054	-36.20677	185	
081019	13:50	OPT012	N	14.09327	-34.36016	187	no FRRF
081020	14:00	OPT013	Y	10.89155	-32.20646	107	
081021	13:45	OPT014	Y	7.66271	-30.05939	187	
081022	13:50	OPT015	Y	5.13906	-28.39094	185	
081023	13:45	OPT016	Y	1.82972	-26.21483	181	
081024	13:20	OPT017	Y	-1.62899	-24.99385	183	
081025	14:00	OPT018	Y	-6.05280	-24.97606	185	
081026	13:40	OPT019	Y	-9.97521	-24.99948	185	
081027	13:45	OPT020	Y	-13.99438	-24.99525	187	
081028	13:45	OPT021	Y	-16.87545	-24.99616	185	
081029	13:50	OPT022	Y	-20.28327	-25.00107	187	
081030	13:50	OPT023	Y	-23.93448	-24.99943	185	
081031	14:10	OPT024	Y	-26.55715	-24.9979	187	
081102	15:00	OPT025	Y	-32.17939	-29.82551	185	
081103	15:00	OPT026	Y	-34.55314	-32.98041	183	
081104	14:45	OPT027	Y	-36.17316	-35.05416	185	
081105	14:40	OPT028	Y	-38.76446	-38.46238	183	
081106	14:40	OPT029	N	-41.4747	-42.1439	177	no FRRF
081107	14:30	OPT030	Y	-43.9457	-45.64832	179	
081108	14:25	OPT031	Y	-46.89153	-49.52857	187	

Table 4: Description of the optics stations sampled. A simple yes (Y) and no (N) is given for the presence of usable FRRF data. The latitude and longitude are expressed as decimal degrees.

Table 1 shows the details of the optics stations sampled during the AMT-18 cruise with observations concerning the health of the instrumentation.

Figure 1 shows the variability in phytoplankton health as a function of depth and latitude. Values of Fv/Fm approaching 0.65 are indicative of a physiologically healthy phytoplankton population. Features to note are the deeper deep chlorophyll maximum (DCM) in the southern hemisphere gyre where the maximum in Fv/Fm is below 150 m and extends below the maximum depth sampled. The northern hemisphere DCM appears to be spread over a broader depth range of around 70 m. Surface values of Fv/Fm are likely suppressed by non-photochemical quenching.

Figures 2 and 3 show the data measured by the ac9. The spectral absorption measurements on this cruise were very noisy and a great deal of data processing and calibration was required to make sense of the measurements. However it can be seen in figure 2 that there are some clear optical provinces. The southern hemisphere gyre is characterised by very low a(440) values (<0.02 m^{-1}) down to a depth of 200 m. This corresponds well with the patterns in Fv/Fm shown in figure 1. The high absorption feature at depths greater than 150 m at 10 N may be an interpolation artefact – here there is the unphysical occurrence of absorption being greater than attenuation. Higher values of absorption (> 0.05 m^{-1}) are encountered in the surface waters as the productive Patagonian Shelf region is approached. Unfortunately problems with the instrumentation meant that much of the highly productive waters in the northern hemisphere (north of around 35 N) were not sampled. Figure 3 shows a much smoother signal in the attenuation. Features to note are the slope in higher attenuation across the equatorial upwelling region between the gyres which descends from 50 – 100 m over 20 degrees of latitude, and the high attenuation on the Patagonian Shelf. It is likely that most of the attenuation on the Patagonian Shelf is caused by highly scattering organisms such as coccolithophores as there is very little attendant absorption.

Figure 4 shows the backscattering calculated at 550 nm using the bb6 instrument. The plot was made in Ocean Data View and the latitude is reversed from the previous plot. The Patagonian Shelf region has the highest backscatter (> 0.005 m^{-1}), in line with the comments made concerning figure 3 above. If a conservative factor of b:bbp of 50 is applied this corresponds to scatter (b) of around 0.25 m^{-1} which is consistent with high attenuation (0.3 m^{-1}) and relatively low absorption (0.05 m^{-1}). The backscatter is also enhanced across the equatorial upwelling region. These data will be used in conjunction with the ac9 derived scatter (b) to determine basin scale variability in the backscatter to scatter ratio.

Figure 5 shows the hydrographical parameters measured on the CTD, deployed on the same rig as the ac9 for scattering correction purposes. The two gyres and the equatorial upwelling region are easily recognisable in the temperature signal, as is the reduction in surface salinity over the equator, likely caused by intense precipitation in that region.

Figure 6 shows the variation of spectral UV light with depth. The main feature to note is that UV-A and UV-B both penetrate to greater depth in the southern hemisphere gyre. UV-A (longer wavelengths of 340 and 380 nm) penetrate to greater depth than UV-B. This has implications for photochemistry: from these preliminary plots you would expect the southern hemisphere gyre to be more photochemically active than its northern counterpart.

Figure 7 shows the aerosol optical depth derived from the sun photometric measurements. There is a distinct peak in the AOD around 10 N which possibly corresponds to a Saharan dust outbreak and another minor peak around 35 N. Figure 8 shows the precipitable water (measured using the same instrument as the AOD). Again there is a peak around 10 N of 5 cm which is a function of a warmer, thicker troposphere able to hold more water vapour. There is interesting asymmetry between the northern (NH) and southern hemispheres (SH) with the SH being considerably drier than the NH. These data were collected as part of the NASA AERONET project and the data sent daily to Dr Sasha Smirnov for processing and including in their web database.

Integration:
All the data will be put towards the wider AMT aims including investigations of photochemistry and phytoplankton primary production.

References:
Zaneveld, J.R.V., J. C. Kitchen and C. C. Moore, Scattering error correction of reflecting tube absorption meter, Ocean Optics XII, Proc. Soc. Photo-Optical Instrum. Eng. (SPIE), Vol. 2258, 44–55, 1994.

Twardowski, M. S., Claustre, H., Freeman, S. A., Stramski, D. and Huot, Y. (2007)

Optical backscattering properties of the ċlearest 'natural waters. ***Biogeosciences***, **4**, (6) 1041-1058.

Datasets produced:

In water optics:

i) Merged dataset of ac9, UV and CTD; 31 deployments median binned into 2 m depth intervals. Filenaming convention: AMT18_OPTSSS_ac9_SUV_CTD_fff_yymmdd.txt where SSS is the cast ID (e.g 001); ac9 (ac9), SUV (Spectral UV), CTD (CTD), fff is flt (filtered) or unf (unfiltered), yy (year), mm(month), dd (day).

ii) Binned dataset of FRRF parameters into two separate casts (where appropriate). Filenaming convention: AMT18_OPTSSS_frrf_castx_yymmdd.csv

iii) Binned dataset of bb6 parameters. Filenaming not currently known as needs reprocessing following the final version of the ac9 data.

Atmospheric measurements:

i) Single spreadsheet of aerosol optical depth measurements taken opportunistically during the cruise.

ii) HyperSAS daily files.

Figures

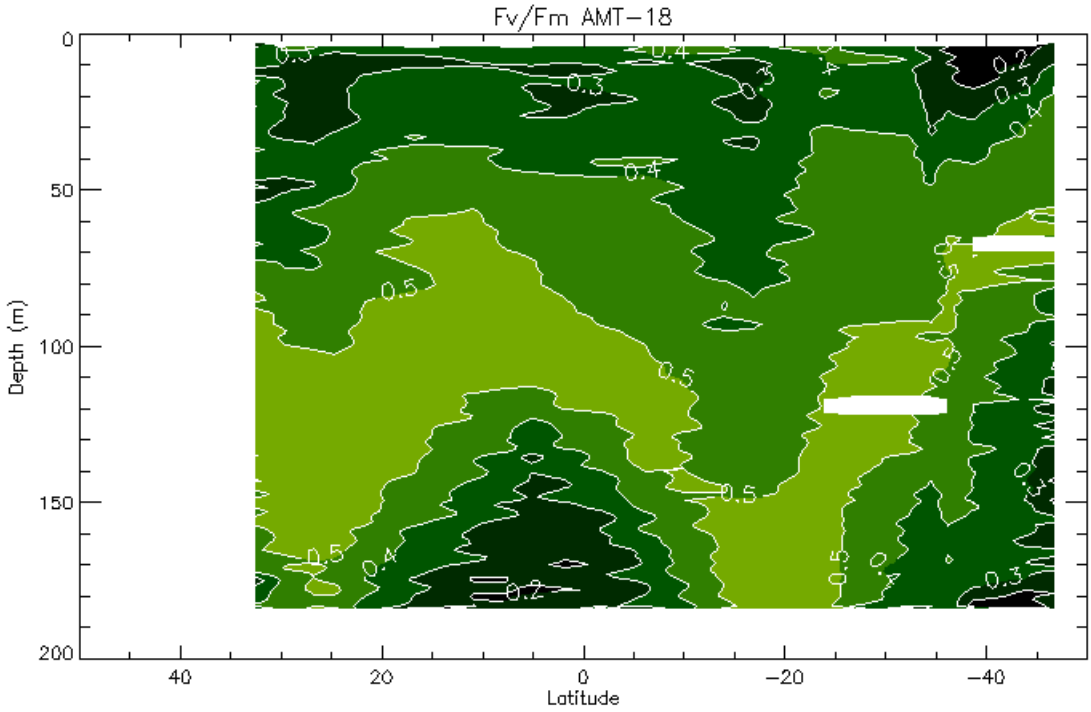


Figure 1: Fv/Fm along the length of the AMT transect

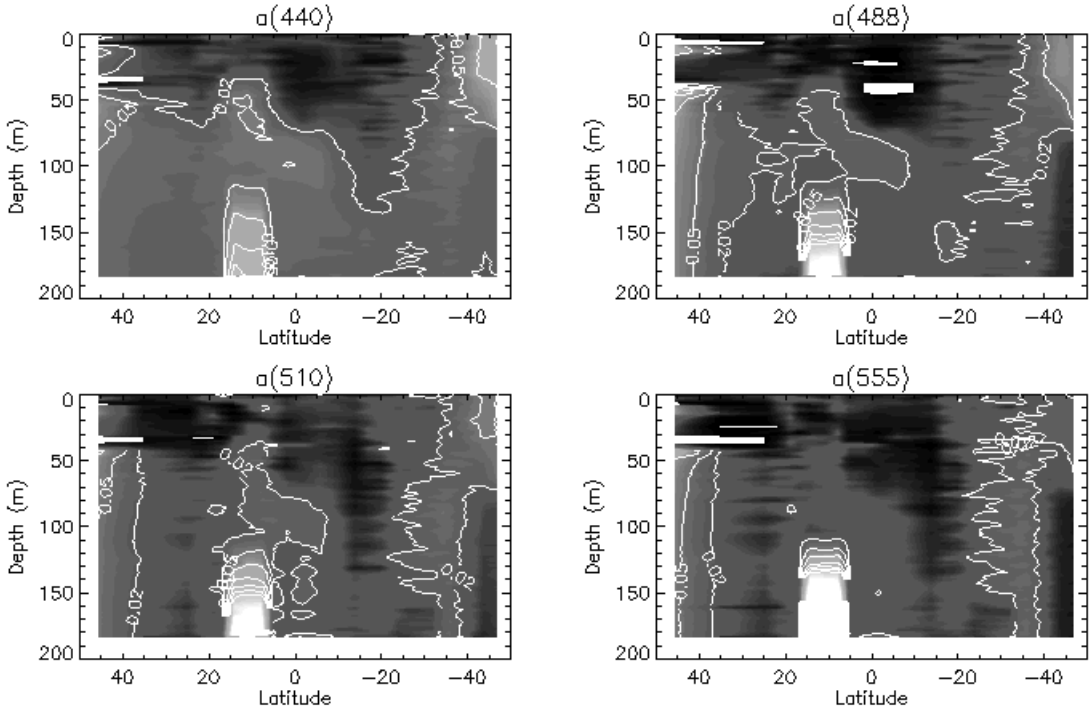


Figure 2: absorption measured by the ac9 along the AMT transect

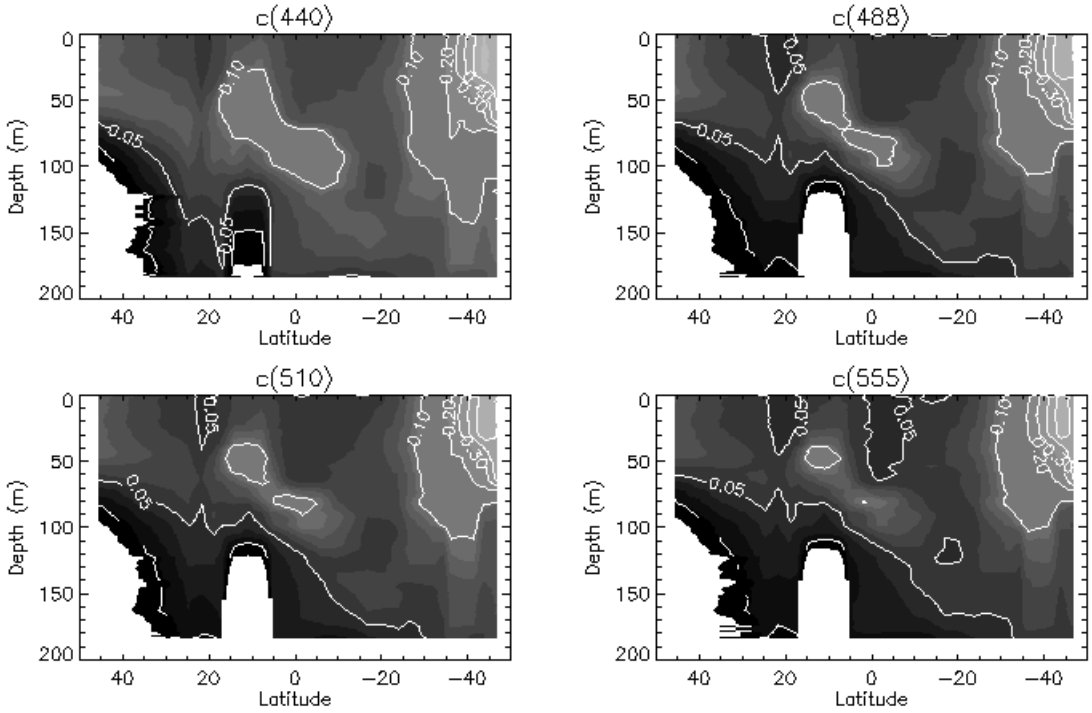


Figure 3: Spectral attenuation measured along the AMT transect.

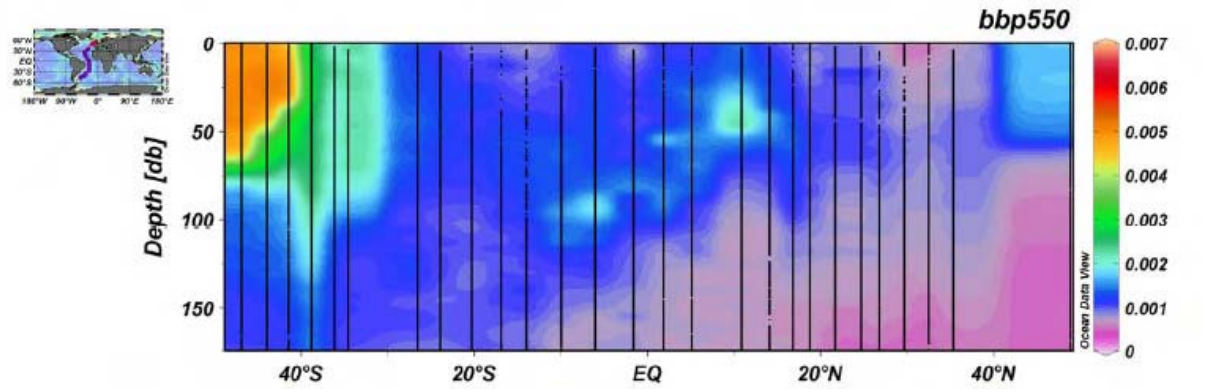


Figure 4: bbp 550 nm from the bb6 (plotted in opposite way to figures 1 – 3 and figure 5)

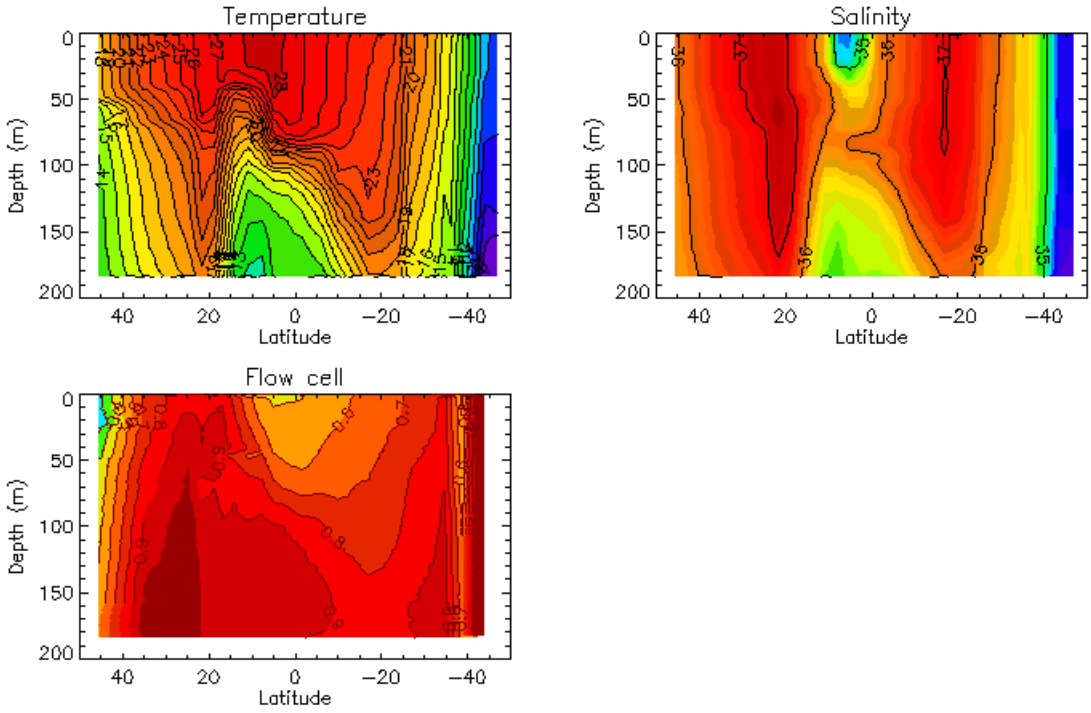


Figure 5: Hydrographical parameters measured along the length of the AMT transect.

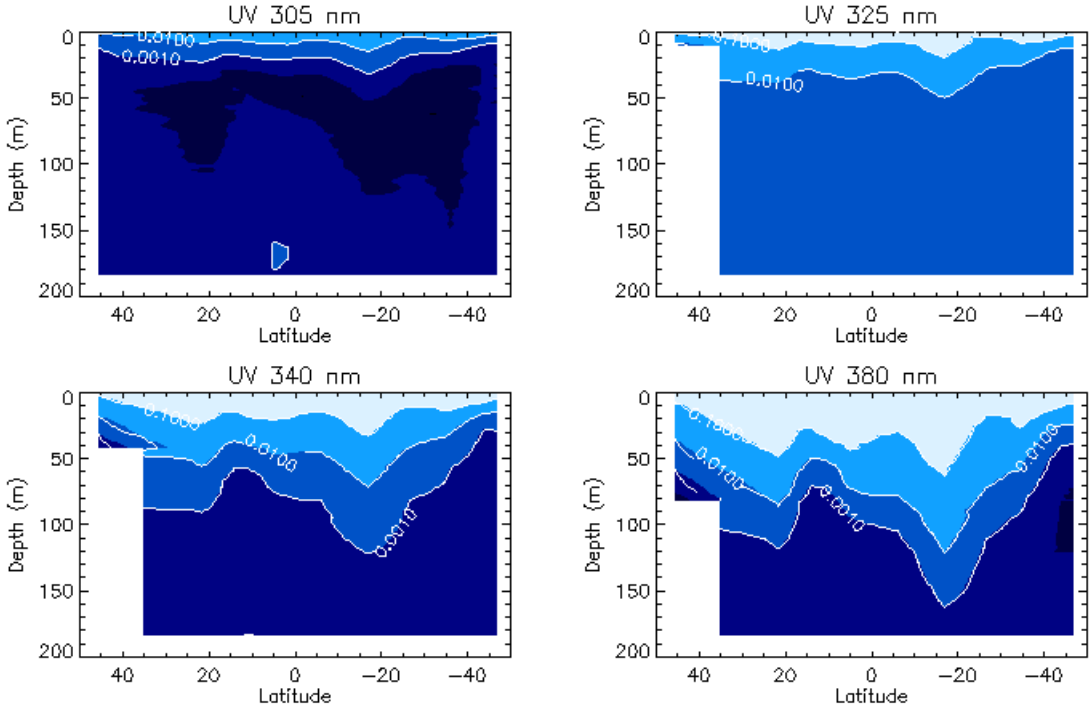


Figure 6: Spectral UV light measured along the length of the AMT transect. Values are normalised to the surface value, therefore 0.01 is the 1% light level.

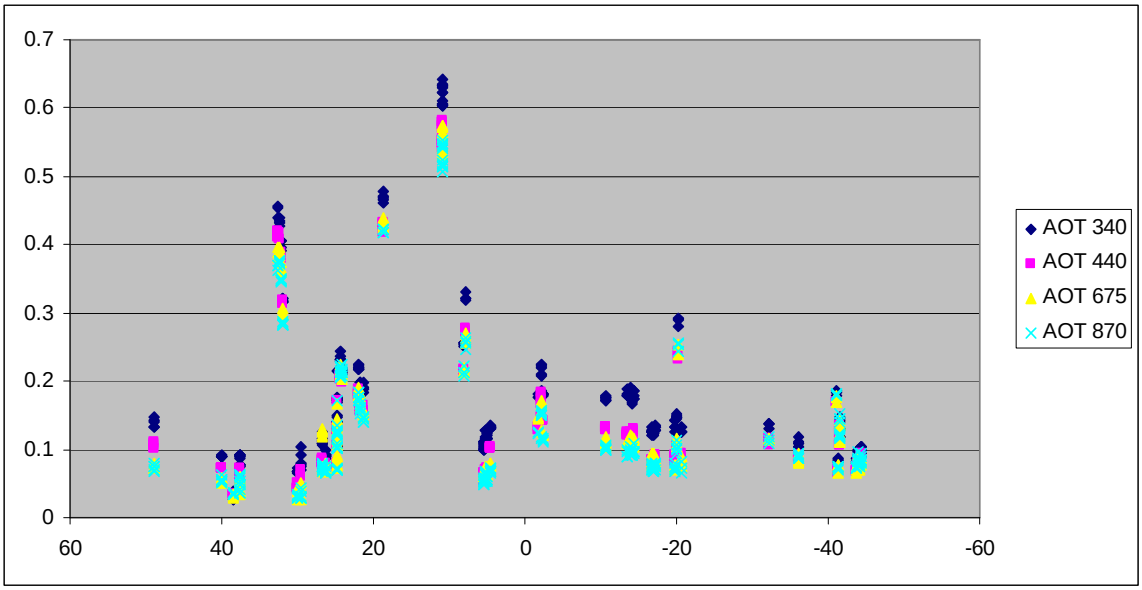


Figure 7: Microtops derived aerosol optical depth measurements over the length of the AMT transect. Blue squares – 340 nm; pink squares 439 nm; yellow triangles 675 nm; cyan crosses 870 nm.

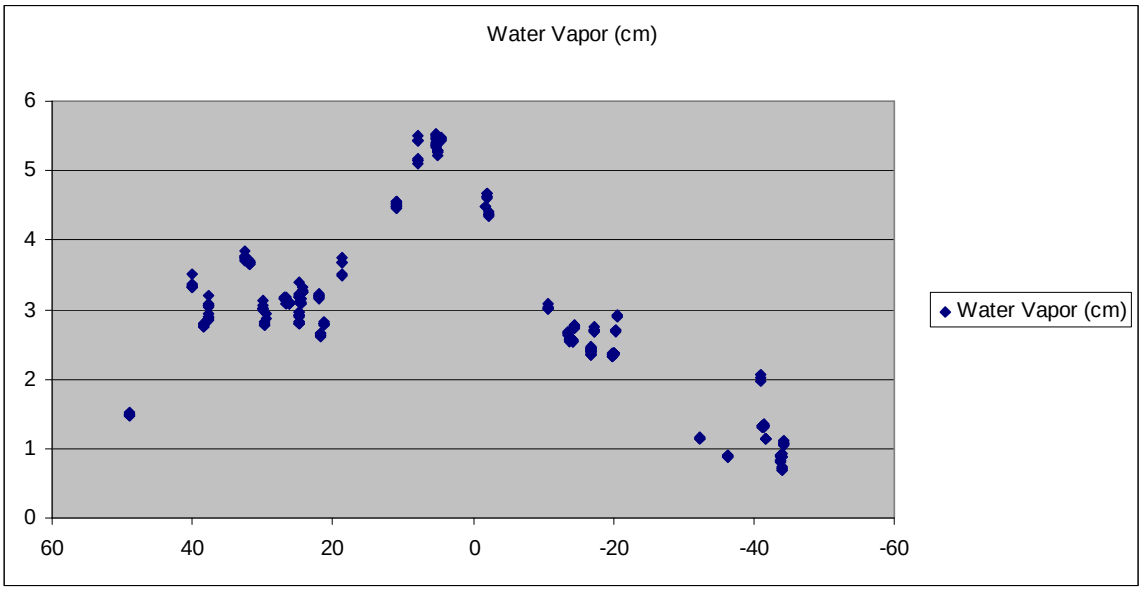


Figure 8: Microtops measured precipitable water vapour over the AMT transect.

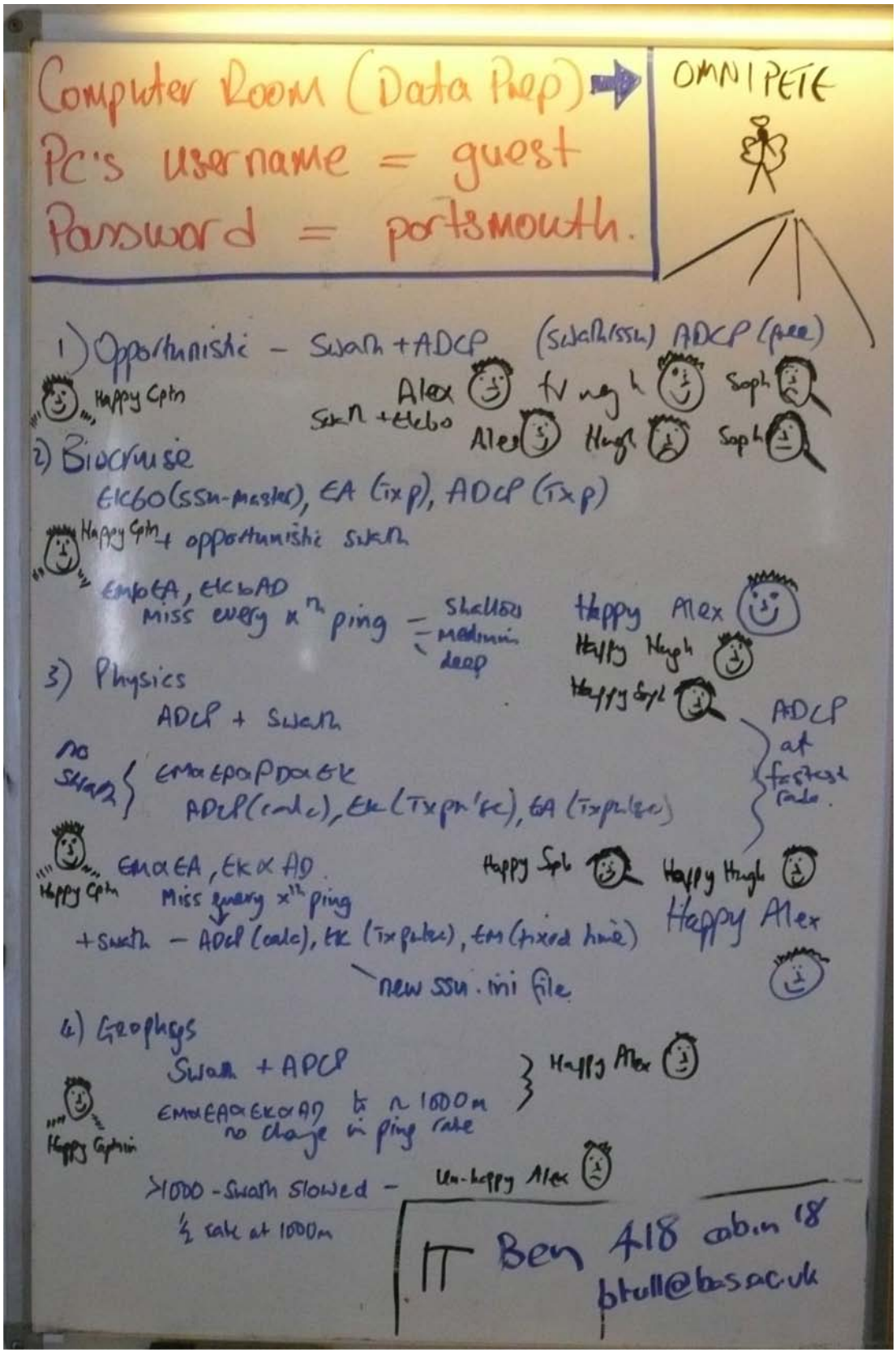
Appendix

Measurement	Instrument	Manufacturer	Model	Serial number	Calibration
In-water UV (305, 320, 340, 380 nm)	UV sensor	Satlantic	507-UV	168	19th Feb 2009 Satlantic; used post cruise calibration (Di168b.cal)
phytoplankton phys.	FRRF	Chelsea	FRRF 1	182042	19th June 2008 Chelsea
PAR	PAR sensor	Chelsea	not known	not known	
Depth	Depth sensor	Druck	not known	not known	
Temperature, Salinity	CTD	SeaBird	SBE19+	19P27903-4180	12th Dec 2001 Seabird
backscatter at 6 wavelengths 442, 488, 550, 620, 671, 852	hydroscat 6	Hobilabs	bb6	HS020332	4th April 2007
absorption / attenuation at 412,440, 488,510,532,555,650,676, 715 nm	ac-9	Wetlabs	ac9+	ac90265	11th May 2005 Wetlabs
HyperSAS	Radiometer - vertical	Satlantic	OCR-R	258	29th September 2006 - Satlantic
	Radiometer -45	Satlantic	OCR-R	023	29th September 2006 – Satlantic
	Radiometer +45	Satlantic	OCR-R	022	29th September 2006 - Satlantic
Incident UV (200 – 500 nm at 2.5 nm resolution)	Hyperspectral UV sensor	Trios	ACC2 UV	010-05-501F	Manufacturer's original calibration but with
Aerosol Optical Depth	sunphotometer	SOLAR light co.	microtops II	03759	not known but regularly calibrated at Goddard.

Table 5: Description and serial numbers of instruments used on AMT-18. Highlighting is used to show instruments used as a unit.

JR218 Acoustic trials

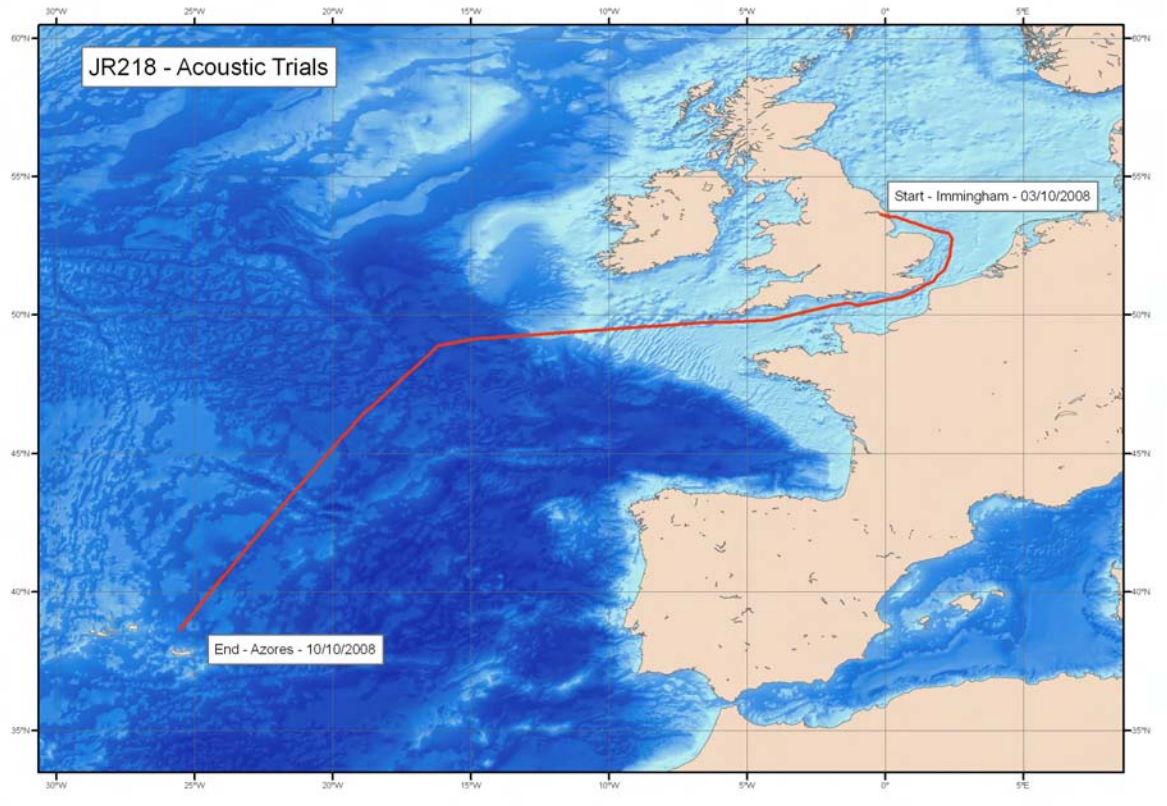
Sophie Fielding, Peter Enderlein, Alex Tate, Hugh Venables



Contents:

1. Cruise narrative:

JR218 departed from Immingham on Friday 3rd October, arriving near the Azores Friday 10th October 2008. JR218 is itself the Atlantic Meridional Transect (AMT) cruise, led by Malcolm Woodward (Plymouth Marine Laboratories, PML). Malcolm kindly let four BAS staff (Peter Enderlein, Sophie Fielding, Alex Tate, Hugh Venables) join to undertake acoustic trials during AMT's annual transect from the UK to the Falkland Islands (BAS staff departing in the Azores via a boat transfer). During the 7 days on board there were 2.5 days of shallow water (<100m), 4.5 days of deep water (>2000m) and ~12 hours crossing the shelf.



2. Purpose:

The JCR has a multitude of acoustic instruments that are fundamental to differing scientific disciplines and for ships navigational purposes. They operate at a variety of frequencies and, for quality purposes (interference), ping rates (sampling rates, travel time). The instruments are susceptible to interference through either mechanical noise, ringing in the hull or harmonic interference. Typically scientists of different disciplines operate using their primary acoustic instrument and turning other sounders off as or if they cause interference. This prevents the collection of other data at opportunistic times. The aim of this cruise was to document the settings required (through a sound synchronisation unit – SSU) to operate all sounders at sampling rates that would create excellent or satisfactory sampling rates for all instruments. Personnel representing all relevant disciplines were required to ensure data quality was achieved, whilst ships personnel reported on results satisfactory to them.

3. Overview of acoustic instruments

The RRS James Clark Ross has both scientific and navigational sounders mounted on her hull. The navigational systems are a Doppler logger, two shallow ships echosounders (JRC echosounders) and a deep-water echosounder (Simrad EA600). The scientific systems are a swath bathymetry multibeam (Simrad EM120), biological echosounder (Simrad EK60), Acoustic Doppler Current Profiler (ADCP, RDI Ocean Surveyor), sub-bottom profiler (Simrad TOPAS), under water positioning system (Ultra Short BaseLine– USBL Sonardyne) and precision echosounder (PES).

In order to minimise interference some of the scientific instruments (EM120, EK60, TOPAS, ADCP) and the navigational deep-water echosounder (EA600) are interfaced through the Sound Synchronisation Unit (SSU) that allows, through user defined settings, the instruments to ping either synchronously or sequentially. The following information relates only to those sounders that can be controlled by the SSU.

3.1 Simrad EA600

The Simrad EA600 is the ships deep-water navigational echosounder. It has a single beam and operates at 12 kHz. Management of the echosounder can be either from the bridge (when operating on internal trigger) or from the UIC when interfaced with the SSU. The bridge uses the “scroll lock” key on their keyboard to allow control to the UIC (from the monitor and keyboard near the winch cabin). The EA600 runs in active mode unless the EM120 is running, in which case it is reset to passive (although it can be run in active mode in water depths up to ~800m without interfering). The bridge maintains control whenever it is required by them for navigational purposes. Control can be recovered by the bridge at any time, however if the EA600 is synchronised with the EM120 (and TOPAS) the EM120 should be stopped to prevent harmonic interference and false bottom readings.

Possible sources of errors, noise and interference:

1) False bottoms created by reflections from EM120 signal (solution – synchronise EA600 and EM120)
2) False bottoms created by reflections from TOPAS signal (solution – synchronise EA600 and TOPAS)

3.2 Simrad EM120

The Simrad EM120 is the swath bathymetry system, operating with multiple beams (191 receiving beams (~1° beam-width)) to widths of ~130° with frequencies centring at 12 kHz. At present it only collects bottom topography data and not water column backscatter. The EM120 has five modes –very shallow, shallow, medium, deep and very deep – and switches between these automatically (it appears that the shallow/medium to deep switch occurs around 1000m). With increasing depth mode there is increasing power into the water (and as a result the trigger becomes longer).

The EM120 trigger is nearly always managed using the SSU, so that it is interfaced with the EA600 (operating in passive mode). This way the EA600 uses the central beam of the EM120 as its signal. It should be noted that the EM120 requires ~200ms from the trigger

signal received to transmitting to calculate pitch and yaw stabilisation. This means that in any configuration when all instruments are triggering together, the EM120 must be master (this is set within the SSU.ini file).

Possible sources of errors, noise and interference:

1) False depths created by false reflections from EA600 signal (solution – synchronise EM120 and EA600 and convert EA600 to passive)
2) False depths created by reflections from TOPAS signal (solution – synchronise EM120 and TOPAS)

3.3 Simrad EK60

The Simrad EK60 is the biological echosounder and has 3 transducers operating at 38, 120 and 200 kHz. Each is a split beam transducer with a beam angle of 7° for the 120 and 200 kHz and 9° for the 38 kHz. Typically data is saved to a maximum depth of 1000m, where noise starts to mask signals, even at the lowest frequency (38 kHZ). The ping rate is versatile, although biological surveys tend not to run slower than one ping every two seconds. For true biological measurements of quantified acoustic backscatter, the EK60 requires calibration in “typical” sampling waters using standard sphere techniques (Foote et al. 1987).

Of all the acoustic instruments on the JCR, the EK60 appears to be the most susceptible to noise and interference. As a result the EK60 must be run through the SSU. A quirk of the EK60/SSU interface is that the EK60 crashes if you turn the trigger on in the SSU before switching the trigger on in the EK60 software.

Possible sources of errors, noise and interference are:

1) Ringing in the hull from other transducers pinging (solution – synchronise all)
2) Harmonic interference from similar frequency instrument – either USBL or ships Doppler logger (solution – turn off USBL, request the Doppler logger turned off if possible)
3) Mechanical noise in the ship increasing echosounder background noise, such as nail gunning in/near the transducer spaces (solution – ask to stop if possible)

3.4 Ocean Surveyor

The Ocean Surveyor (ADCP) measures ocean currents. It consists of 4 transducers, operating at 75 kHz, “looking” in four equidistant directions (e.g. N, S, E, W) each angled at 30° from vertical. The ADCP runs in two modes, narrowband and broadband, that are user-defined and not relevant to interference issues discussed here. In addition the ADCP has two further modes (operating in both narrowband and broadband) that affect its ping rate and settings: a bottom-tracking mode for calibration purposes that operates in water depths shallower than ~800m and a water column mode to maximise data collection over the water column. Data can be collected to ~750 m in reasonable seas, with smaller depths attained in rough seas. The ping rate of the ADCP is dependent on the depth settings defined in the command file (the number of bins to record data over), even if this depth is deeper than the bottom.

Calibration of the ADCP corrects for the misalignment of the transducers and the ships direction. This can vary with the load and trim of the ship and it is therefore necessary to calibrate the ADCP for each cruise. In bottom tracking mode, in the user defined settings used by BAS, the ADCP emits one bottom tracking ping for every water column ping. In water column mode, only water column pings are transmitted.

Possible sources of errors, noise and interference are:

1) Consistent depth interference from ringing in the hull from other transducers pinging (solution – synchronise)
2) Slow ping rates affecting data quality (solution - change synchronicity settings, only run in bottom tracking mode for calibration purposes)

3.5 TOPAS

TOPAS is a sub-bottom profiling system. It operates with a chirp style signal that ranges up towards 12 kHz and so, in addition to a large ringing of the hull, can cause false reflections in the EA600 and EM120. We did not have sufficient TOPAS expertise on this cruise and so it plays no further part in this report.

4. The Sound Synchronisation Unit (SSU)

Most acoustic instruments have built-in external trigger control that allows the devices to be controlled by an external controlling system – on the JCR this is the SSU. The SSU receives the trigger inputs from the various acoustic systems and transmits the synchronised trigger signal back to the appropriate systems. In this way the acoustic systems can be set to trigger synchronously or sequentially depending on what modes and groups the instruments are assigned to. The general principle of operation for the SSU is:

1) The parameters and operating frequencies of the acoustic systems are studied and the systems are allocated into different groups depending on their likelihood of causing interference to each other. The groups of systems can then be operated in separate time blocks. A mode consists of a collection of groupings of instruments, the SSU (or each SSU.ini file) can only display four modes
2) All the systems in one group are triggered simultaneously, and the next group will wait until all the instruments have triggered and/or finished their data collection (depending on instrument SSU settings)
3) Once a group has finished its triggering allocation, the next group is triggered. Once all groups have finished their triggering allocation, the sequence starts again from the beginning (up to 64 triggering sequences, including repetition of groups can be programmed in the SSU.ini file)
4) The actual transmission signal of each acoustic system is monitored, if the signal is not detected the instrument is assumed to be off or in passive mode. The SSU then assumes that their reception time requirement is zero and will not occupy any time in the sequence
5) Each systems trigger usage is displayed on the display unit. When a system is controlled by the SSU and waiting for a trigger, its line is green; when a system is actively controlled by the SSU (during transmit times), its line is red; and when a system is off or not controlled by the SSU the line is grey

The SSU controls can be set in two places, each place enabling a variety of functions. For basic manipulations the user utilises the joystick control using displayed options on the main display unit (above the EM120 in the UIC). Functions permitted using this are related to operating acoustic systems in predefined modes, setting trigger commands on or off and allocating time slots for those systems (tx pulse, calculated or fixed time, see section ??). There are also additional functions for particular acoustic systems (e.g. EA600 and TOPAS) such as percent time addon, multipulse and depth. For details of SSU joystick operation and details about the additional functions please refer to the SSU manual.

For more complex manipulations of the system, different controls can be set in the SSU configuration file (SSU.ini). PLEASE backup the existing SSU program before editing this file (see appendix 1 for details of how). PLEASE also make sure you know what you are doing, there are hardware options in this file that could result in the wrong voltage signal being sent to a transducer – NOT GOOD! Editing the SSU.ini file will allow the user to define different groups of instruments and different trigger sequences (see appendix 2 for details of editing the SSU.ini file).

5. Operational settings for different discipline cruises

In an ideal world there would be one setting needed on the SSU to make all acoustic instruments function perfectly for all scenarios. It isn't an ideal world! Therefore we detail here suggestions for operating the acoustic instruments under different cruise scenarios: opportunistic, biology, geology and physics. Within each of these groupings are methods for

collecting solely the relevant acoustic instruments data and various permutations depending on other requirements.

In order to synchronise the JCR acoustic instruments it may be that a user will have to operate an unfamiliar instrument. As with your own, all the acoustic instruments described here have various constant settings that, if changed, could detrimentally affect the performance of the instrument. We would remind any user to only change the settings of an instrument, beyond those mentioned here, if they know what they are doing and what it will do. In the latter cases it would be useful if any changes could be documented and left for the next user.

Operational guidelines for each instruments are given in appendix 3 (Quick guide to the SSU joystick controls), appendix 4 (EA600 navigational echosounder), appendix 5 (EM120 swath bathymetry), appendix 6 (EK60 biological echosounder) and appendix 7 (ADCP current profiler).

5.1 Opportunistic cruise settings

We define an opportunistic cruise here as one where there are no scientists onboard. The instruments would be setup, started and stopped by either ITS, ETS or a ship's personnel. We present three sets of settings; it is not possible for all acoustic instruments to be working at satisfactory rates without a "familiar" user's input. The following setups are available: swath bathymetry only; swath bathymetry and ADCP; swath bathymetry and EK60.

Table 5.1.1. Opportunistic SSU mode and settings

Setup	Group	Time usage			
		EA600 (passive)	EM120	EK60	ADCP
Swath only	EM&EA&EK&AD	Tx pulse	Calculated	Off	Off
Swath + ADCP	EM&EA&EK&AD	Tx pulse	Calculated	Off	Free running*
Swath + EK60	EM&EA&EK&AD	Tx pulse	Calculated	Free running	Off

* Free running – means not controlled by the SSU (on internal trigger)

Table 5.1.2. Opportunistic instrument settings

Instrument	Comments
EA600	Needs to be in passive mode, external trigger, max ping rate
EM120	Active mode, auto settings, may need to manually find depth at points
EK60	Internal trigger, 2 second ping rate, interference removed in processing
ADCP	Water depth <500m load command file JCR_BT_opp.txt Water depth >500m load command file JCR_WC_opp.txt

It is assumed that the nominated person to switch these instruments on would check that all instruments were working at least once a day, preferably more.

5.1.1 Impact on ADCP sampling rates

Since the ADCP is in free running mode, there is no impact on ping rate. Ringing in the hull causes interference in the backscatter signal. So far, as long as the interference is random and not at the same depth all the time, this has not been shown to have detrimental effect.

5.1.2 Impact on EK60 sampling rates

Since the EK60 is in free running mode, there is no impact on ping rate. Ringing in the hull causes interference in the backscatter signal. This will have to be removed at the data processing stage.

5.2 Biology cruise settings

Biology cruises have been separated into the following groups related to optimal settings: Biology only, Biology and ADCP, Biology and ADCP and swath. Although they are detailed here, there is **no reason** to only operate the EK60 on its own; the settings for biology and ADCP cover the EK60, ADCP and EA600 at the ideal sampling rate for the EK60. In order to run the swath it is important that the correct SSU.ini file is loaded (SSU_EK60.ini). The shallow, medium and deep groups below are setup so that the swath will ping once and then

the EK, ADCP group will ping several times (dependant on depth settings) before starting again.

Table 5.2.1. Biology cruise SSU mode and settings

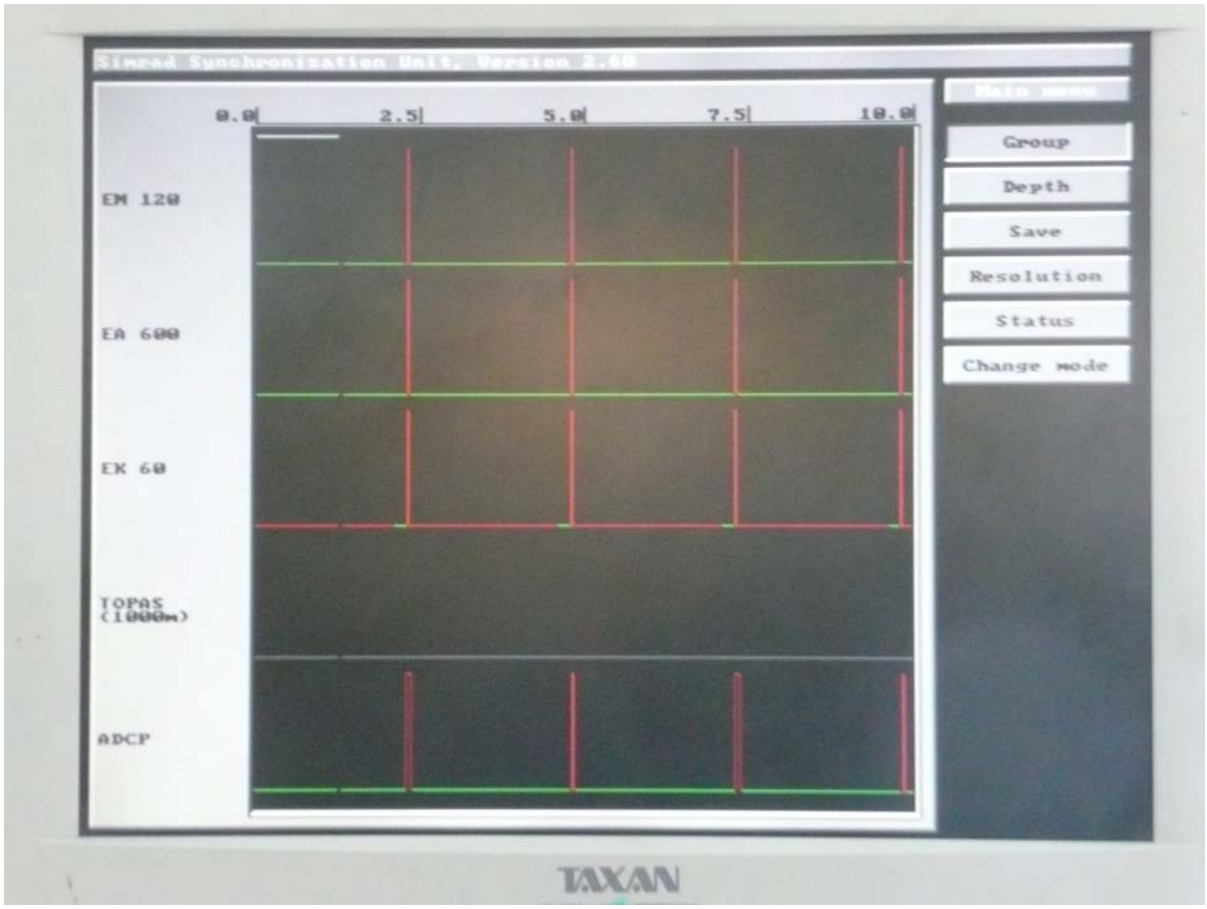
Setup	Group	Time usage			
		EA600	EM120	EK60	ADCP
EK60+EA600	EM&EA&EK&AD	Tx pulse (active)	Off	Calculated	Off
EK60+EA600+ADCP	EM&EA&EK&AD	Tx pulse (active)	Off	Calculated	Tx pulse
EK60+EA600+ADCP+EM120 Water < 500	EM&EA&EK&AD	Tx pulse (passive)	Tx pulse	Calculated	Tx pulse
EK60+EA600+ADCP+EM120 Water >500	EM&EA EK&AD	Tx pulse (passive)	Fixed time (500ms)	Calculated	Tx pulse
EK60+EA600+ADCP+EM120 Water >2500	EA&EM EK&AD	Tx pulse (passive)	Fixed time (500ms)	Calculated	Tx pulse
EK60+EA600+ADCP+EM120 Water >5000	EM&EA AD&EK	Tx pulse (passive)	Fixed time (500ms)	Calculated	Tx pulse

Table 5.2.2. Biology cruise instrument settings

Instrument	Comments
EA600	Need to be active, external trigger when EM120 off, otherwise passive, max ping rate
EM120	Active mode, 60° beam fan on either side, auto settings, may need to manually find depth at points. Requires updating Sv profile if needed
EK60	Water depths <500m use a 3 second ping rate, for depths >500m use 2 seconds* External trigger
ADCP	Water depth <250m load command file JCR_BT250.txt Water depth <500m load command file JCR_BT500.txt Water depth >500m load command file JCR_WC800.txt

* If using a different ping rate, the shallow, medium and deep settings may need tweaking in the SSU.ini file to prevent the system crashing.

An example of the SSU display with the settings for EK60+EA600+ADCP+EM120 Water < 500 is given below.



5.2.1 Impact on ADCP sampling rates

The biology settings above impact on the ping rate of the ADCP. As long as a 2 second or faster ping rate is set on the EK60 the ADCP should collect at an adequate rate. When in bottom tracking mode and in deep water the ADCP ping rate is slowed to 1 water column ping every 4 seconds. It is possible that in shallow waters (e.g. <500m) the EK60 ping rate should be increased to 1.5 seconds so that the sampling resolution of the ADCP increases to 3 seconds, or alternatively slow the EK60 to 2.5 seconds to allow the ADCP to ping with every trigger. It should be noted; in deep water the ADCP has a free running ping rate of 3.1 seconds (with JCR_WC800.txt command file). In order to optimise the ADCP ping rate the EK60 needs to be slowed to a ping rate of 3.2 seconds, or sped up to 1.6 seconds. Alternatively, accept the slower ADCP sampling rate of 1 ping per 4 seconds.

5.2.2. Impact on EM120 swath sampling rates

The biology settings above impacts on the ping rate of the swath bathymetry EM120. Trigger settings in the groupings “EM&EA EK&AD”, “EA&EM EK&AD” and “EM&EA AD&EK” allow the swath to ping at a rate of:

EM&EA EK&AD – 1 ping every 10 seconds
EA&EM EK&AD - 1 ping every 20 seconds
EM&EA AD&EK - 1 ping every 30 seconds

5.3 Physics cruise settings

Physics cruises have been separated into the following groups related to optimal settings: physics only, physics and biology, physics and swath, physics and biology and swath. In order to run the physics, biology and swath, optimised for the physics, the correct SSU.ini file should be loaded (SSU_ADCP.ini).

Table 5.3.1. Physics cruise SSU mode and settings

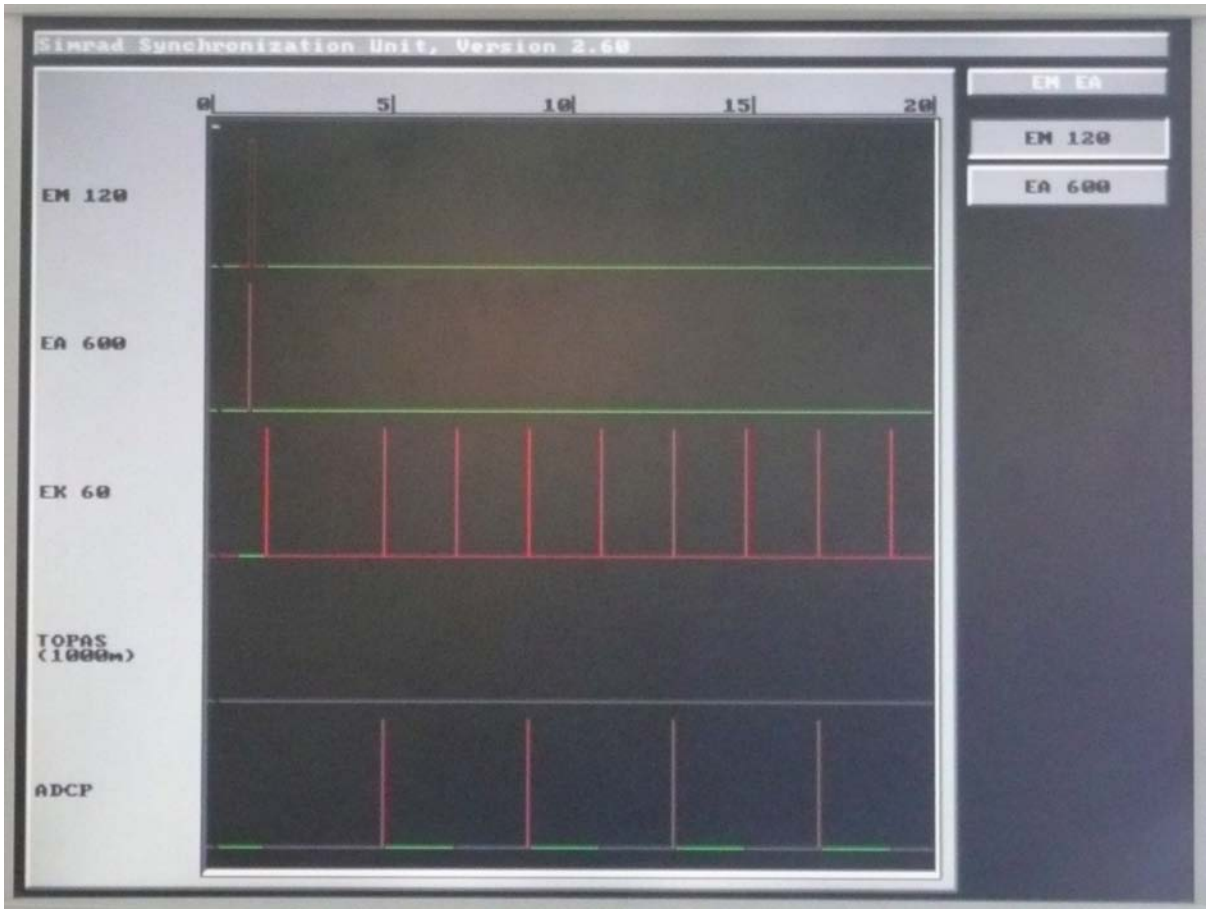
Setup	Group	Time usage			
		EA600	EM120	EK60	ADCP
ADCP+EA600	EM&EA&EK&AD	Tx pulse (active)	Off	Off	Calculated
ADCP+EK60+EA600	EM&EA&EK&AD	Tx pulse (active)	Off	Tx pulse	Calculated
ADCP+swath	EM&EA&EK&AD	Tx pulse (passive)	Calculated	Off	Free running
ADCP+EA600+EK60+EM120 Water < 500	EM&EA&EK&AD	Tx pulse (passive)	Tx pulse	Tx pulse	Calculated
ADCP+EA600+EK60+EM120 Water >500	EM&EA EK&AD	Tx pulse (passive)	Fixed time (500ms)	Tx pulse	Calculated
ADCP+EA600+EK60+EM120 Water >2500	EA&EM EK&AD	Tx pulse (passive)	Fixed time (500ms)	Tx pulse	Calculated
ADCP+EA600+EK60+EM120 Water >5000	EM&EA AD&EK	Tx pulse (passive)	Fixed time (500ms)	Tx pulse	Calculated

Table 5.3.2 Physics cruise instrument settings

Instrument	Comments
EA600	Need to be active, external trigger when EM120 off, otherwise passive, max ping rate
EM120	Active mode, 60° beam fan on either side, auto settings, may need to manually find depth at points. Requires updating Sv profile if needed
EK60	External trigger, assumes 2 second ping rate
ADCP	Water depth <250m load command file JCR_BT250.txt* Water depth <500m load command file JCR_BT500.txt* Water depth >500m load command file JCR_WC800.txt*

* If using a different ping rate (varied by the depth/no of bins in the ADCP command file), the shallow, medium and deep settings may need tweaking in the SSU.ini file to prevent the system crashing.

An example of the SSU display with the settings for ADCP+EA600+EK60+EM120 Water >2500



5.3.1 Impact on EK60 sampling rates

If data acquisition is optimised for ADCP data collection, the EK60 data ping rate will be variable and slowed. In deep water the ping rate of the ADCP is 1 ping per 3.1 seconds. The alternative settings is to have EK60 as master (see EK60+ADCP+EA grouping in biology cruise), this though will impact the ADCP ping rate albeit slowing only slightly and so should be considered if a biological acoustic user is onboard.

5.3.2 Impact on EM120 swath sampling rates

The physics settings above impacts on the ping rate of the swath bathymetry EM120. Trigger settings in the groupings “EM&EA EK&AD”, “EA&EM EK&AD” and “EM&EA AD&EK” allow the swath to ping at a rate of:

EM&EA EK&AD	– 1 ping every 10 seconds
EA&EM EK&AD	- 1 ping every 20 seconds
EM&EA AD&EK	- 1 ping every 30 seconds

5.4 Geophysics cruise settings

Geophysics cruises have been separated into three possible groupings. These are the same as opportunistic cruises: swath bathymetry only; swath bathymetry and ADCP; swath bathymetry and EK60.

Table 5.4.1. Geophysics SSU mode and settings

Setup	Group	Time usage			
		EA600 (passive)	EM120	EK60	ADCP
Swath only	EM&EA&EK&AD	Tx pulse	Calculated	Off	Off
Swath + ADCP	EM&EA&EK&AD	Tx pulse	Calculated	Off	Free running*
Swath + EK60	EM&EA&EK&AD	Tx pulse	Calculated	Free running	Off

* Free running – means not controlled by the SSU (on internal trigger)

Table 5.4.2. Geophysics instrument settings

Instrument	Comments
EA600	Needs to be in passive mode, external trigger, maximum ping rate
EM120	Active mode, auto settings, may need to manually find depth at points
EK60	Internal trigger, 2 second ping rate, interference removed in processing
ADCP	Water depth <250m load command file JCR_BT250.txt Water depth <500m load command file JCR_BT500.txt Water depth >500m load command file JCR_WC800.txt

5.4.1 Impact on ADCP sampling rates

Since the ADCP is in free running mode, there is no impact on ping rate. Ringing in the hull causes interference in the backscatter signal. So far, as long as the interference is random and not at the same depth all the time, this has not been shown to have detrimental effect.

5.4.2 Impact on EK60 sampling rates

Since the EK60 is in free running mode, there is no impact on ping rate. Ringing in the hull causes interference in the backscatter signal. This will have to be removed at the data processing stage.

6. General observations of instrument performance

During this time a variety of SSU and instrument settings were tested and data were examined and processed on board to determine any detrimental effects. SSU settings trialled are detailed in Table 6.1. The settings laid out in the report above document the most ideal settings created for each discipline.

6.1.1 EA600

The EA600 is a relatively robust instrument. On this cruise it did not crash, although some of us have experienced it doing so before (which required a power cycling to sort). When synchronised with the EM120, the data rate of the EA600 is reduced and the bottom echo is of a reduced strength. In shallow water (<1000m) the EA600 display can be set to 30log(r) to ramp colours on the screen for easier visual bottom detection, below this it has to be returned to 20log(r) as noise is ramped up with depth also. Since the EA600, in passive mode, is using the EM120 central beam as its signal it is not possible to increase the power into the water to increase the EA600 bottom signal.

Once the EM120 has switched to deep mode the transmit pulse is lengthened and will show up in the surface of the EA600 display. Normally, however, the bridge moves the range of the display to lower waters and this can't be seen. If the bottom detection mode has not been selected to look at depth, occasionally it can wrongly detect this surface noise as the bottom. This can be rectified easily by setting the bottom detection range lower.

6.1.2 EM120

The EM120 has stalled occasionally as we have changed SSU settings. On the whole it could be restarted again simply by switching the EM120 off active pinging and the switching to active. A note of caution is its capacity to increase the power it transmits into the water, and hence transmit time, with increasing depth. As a result it "holds" on to the SSU signal for longer. This longer transmit time is associated with a longer hull ringing that can be identified in the other echosounders as interference.

An additional feature that is not yet understood is exactly how it interfaces with the SSU. When operating in the same group as other instruments or alternate it seems to hold some control of the SSU triggering capacity which in turn can influence the ping rate of the other echosounders despite their settings being for a constant ping rate.

6.1.3 EK60

The EK60, whilst stable when free running, crashed several times when interfaced with the SSU and synchronisation settings were changed. This appears to be linked to two scenarios, the first) when the EM120 "held on" to the signal whilst the EK60 was trying to ping – there appears no way at present to resolve this. The second, more easy to fix, is the order in which

the EK60 and SSU are set to start pinging. When controlling the EK60 through the SSU it is important to start the EK60 pinging (with external trigger control), before starting the EK60 pinging through the SSU control. The other way round causes an automatic crash and the EK60 has to be power cycled.

6.1.4 ADCP

The ADCP was very stable, continuing even when SSU settings were changed and the trigger stopped and started from the SSU without stopping it at the ADCP computer. There were independent problems in the navigation feed into the ADCP which were addressed and are detailed in Appendix 9.

6.1.5 SSU

The SSU is relatively robust, in that it either works, or falls over completely if something in the code is wrong. In order to upload SSU files you just copy whatever ini file you require over the SSU.ini file. There are quirks with getting the instruments to ping, sometimes it is easiest to set all the time usage as calculated, set all the instruments to pinging and then change their time usage (not mid trigger!). In this way they seem to sort themselves out and are usually happy. The EM120 interface is usually stable and can cope with being turned on and off by the SSU, likewise the ADCP and EA. The one instrument that is highly temperamental is the link to the EK60 and it is essential that the EK60 is set pinging on the instrument before starting the trigger on the SSU.

6.2 Recommendations

1) Before each “Antarctic” season interested users in acoustic instrumentation should get together and review the cruise tracks for the coming season – they would identify where opportunistic data could be collected. It would be helpful if a member of ship’s operational side was present.

2) It would be useful to synchronise the EA600 with the EM120 outside of the SSU, in addition to still being able to trigger from the SSU when the swath is not running. In this way the EM120 and EA600 could be removed from the SSU system, allowing solely the EK60 and ADCP to be synchronised so that all instruments could be run with easy settings at adequate ping rates. This is possible but requires input from AME (appendix 8).

Table 5.1 Tested SSU settings and groupings

Time	SSU grouping	EM120	SSU set	EA600	SSU set	EK60	SSU set	Ping rate	ADCP	Mode		TOPAS
08/10/2008 12:00	EM&EA EK&AD (trig 0,1,1,1,1,1,1,1,1,1)	on	fixed time (0.5 secs)	on	Tx pulse (passive)	on	calculated	2 sec	on	WT	tx pulse	off
08/10/2008 10:00	EM&EA EK&AD (trig 0,1,1,1,1,1,1,1,1,1)	on	fixed time (0.5 secs)	on	Tx pulse (passive)	on	calculated	2 sec	on	WT	tx pulse	off
07/10/2008 16:00	EM&EA EK&AD (trig 0,1,1,1,1,1,1,1,1,1)	on	fixed time (2 secs)	on	calculated	on	calculated	2 sec	on	WT	tx pulse	off
07/10/2008 15:01	EM&EA EK	on	fixed time (2 secs)	on	Tx pulse (passive)	on	calculated	2 sec	free running	off		
07/10/2008 13:18												
07/10/2008 10:29	EM&EA, EK, ADCP	on	calculated	on	calculated (pass)	on	calculated	2 sec	free running			off
07/10/2008 09:43	EM&EA, EK, ADCP	on	calculated	on	Tx pulse (passive)	off			free running			off
06/10/2008 18:25	EM&EA&EK&AD	on	tx pulse (master)	on	Tx pulse (passive)	on	calculated	2 sec	on	WT	tx pulse	off
06/10/2008 18:14	EM&EA&EK&AD	on	tx pulse (master)	on	Tx pulse (passive)	on	calculated	2 sec	on	WT	tx pulse	off
06/10/2008 17:51	EM&EA&EK&AD	on	fixed time (2 secs)	on	Tx pulse (passive)	on	calculated	2 sec	on	WT	tx pulse	off
06/10/2008 17:13	EM&EA&EK&AD	on	fixed time (2 secs)	on	Tx pulse (active)	on	calculated	2 sec	on	WT	tx pulse	off
06/10/2008 16:51	EM&EA&EK&AD	on	tx pulse (master)	on	Tx pulse (active)	on	calculated	2.5 sec	on	WT 500	tx pulse	off
06/10/2008 16:41	EM&EA&EK&AD	on	fixed time (1.5 secs)	on	Tx pulse (active)	on	calculated	1.5 sec	on	WT 500	tx pulse	off
06/10/2008 16:30	EM&EA&EK&AD	off		on	Tx pulse (active)	on	calculated	1.5 sec	on	WT 500	tx pulse	off
06/10/2008 16:19	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	2.4 sec	on	WT 500	tx pulse	off
06/10/2008 15:25	EM&EA&EK&AD	on	fixed time (2 secs)	on	Tx pulse (active)	on	fixed time (2 secs)	max	on	WT	tx pulse	off
06/10/2008 15:23	EM&EA&EK&AD	on	tx pulse (master)	on	Tx pulse (active)	on	fixed time		on	WT	tx pulse	off
06/10/2008 15:19	EM&EA&EK&AD	on	tx pulse (master)	on	Tx pulse (active)	on	calculated	2 sec	on	WT	tx pulse	off
06/10/2008 14:55	EM&EA&EK&AD	on	tx pulse (master)	on	Tx pulse (passive)	on	calculated	2 sec	on	WT	tx pulse	off
06/10/2008 14:40	EM&EA&EK&AD	on	tx pulse (master)	on	Tx pulse (active)	on	calculated	2 sec	on	WT	tx pulse	off
06/10/2008 14:25	EM&EA&EK&AD	on	tx pulse (no master)	on	tx pulse	on	calculated	2 sec	on	WT	tx pulse	off
06/10/2008 12:47	EM&EA&EK&AD	on	calculated	on	calculated	off			free running			off
06/10/2008 12:36	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	1.5 sec	on	WT	tx pulse	off
06/10/2008 12:35	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	2.4 sec	on	bt 500	tx pulse	off
06/10/2008 11:21	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	2.4 sec	on	bt 500	tx pulse	off
06/10/2008 11:13	EM&EA&EK&AD	on	calculated	on	Tx pulse (passive)	on	calculated		on	bt 500	tx pulse	off
06/10/2008 09:51	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	2.4 sec	on	BT 500	tx pulse	off

Time	Grouping	EM120	SSU set	EA600	SSU set	EK60	SSU set	Ping rate	ADCP	mode	SSU set	TOPAS
06/10/2008 09:38	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	2.3 sec	on	BT 500	tx pulse	off
06/10/2008 08:34	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	2.5 sec	on	BT on	tx pulse CX1	off
06/10/2008 08:25	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	2.5 sec	on	BT on	tx pulse CX1	off
06/10/2008 08:20	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	2 sec	on		txpulse	off
05/10/2008 17:59	none	off			on active	off			free running			off
05/10/2008 10:55	EM&EA&EK&AD	off		on	Tx pulse (active)	on	calculated	2 sec	on	BT on	Tx pulse	off
04/10/2008 17:45	none	off		on	calculated				free running			off
04/10/2008 15:05	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	2 sec	on		Tx pulse	off
04/10/2008 15:01	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated	2 sec	free running			off
04/10/2008 14:42	EM&EA, EK, ADCP	on	fixed time 2 sec	on	Tx pulse (passive)	off			free running			off
04/10/2008 14:37	EM&EA, EK, ADCP	on	calculated	on	calculated	off			free running			off
04/10/2008 12:39	EM&EA&EK&AD	on	calculated	on	calculated	on	calculated		on	WT	tx pulse CX1	off
04/10/2008 12:30	EM&EA&EK&AD	on	tx pulse	on	Tx pulse (passive)	on	calculated		on	WT	tx pulse CX1	off
04/10/2008 11:50	EM&EA&EK&AD	off		on	tx pulse	on	calculated		on	WT	tx pulse CX1	off

Time	Comment
08/10/2008 12:00	When on tx pulse the EM can get out of sync and hogs all the signals upsetting all sounders,so put back on fixed time allocation
08/10/2008 10:00	Reduced time for EM ping to see if it was okay, and speed up EK and ADCP
07/10/2008 16:00	Checking previous settings with ADCP on also. Seems to get acceptable returns so far - depth constant on the Abyssal plain though
07/10/2008 15:01	Created new ini file. Changed triggering order so basically multiple pings of EK with only one ping of EM - seems happy as long as EM allowed to return to it
07/10/2008 13:18	A variety of settings tested - similar to previous - none worked so far
07/10/2008 10:29	EK keeps falling over. At moment in this setup (water depth 4859m) EK triggering every 20 seconds or so. Want to investigate switching EM to tx pulse, but
07/10/2008 09:43	Checking EM120 trigger rate
06/10/2008 18:25	Everything fell over - seems to happen when EK60 stalls. Turned everything off and on again to restart.
06/10/2008 18:14	940 ms the EM fell over. Changed settings from fixed time to tx pulse and seems to work again
06/10/2008 17:51	Changed EA to passive as starting to get noise in
06/10/2008 17:13	

Time	Comment
06/10/2008 16:51	Settings to see how deep they work to.
06/10/2008 16:41	Trial to add swath. Otherwise values okay. Ping rate a little variable.
06/10/2008 16:30	WCB settings trial.
06/10/2008 16:19	Resetting conditions for 400m and shallower depth
06/10/2008 15:25	Pinging okay together but ping rate not quite 2 seconds (i.e. varying slightly)
06/10/2008 15:23	Set fixed time to 2 seconds. Trying to stop there being a change in the 2 second ping gap
06/10/2008 15:19	Running back from 1000 to 200 m. EA600 loses bottom when in passive. When EM in auto it switches to deep ping mode which gives big ping and makes toc
06/10/2008 14:55	All appears okay 974 m of water
06/10/2008 14:40	All working - em120 pinging every other, likewise ADCP
06/10/2008 14:25	EM120 no longer master - checking whether it can run in this mode.
06/10/2008 12:47	Stopped for CTD
06/10/2008 12:36	Trying to see if increasing EK ping rate synchs with EM120 again.
06/10/2008 12:35	EM120 went out of synch at ~400m although still pinging there were pings out of synch so that the EA gives a false reading
06/10/2008 11:21	Reset to tx pulse as no obvious reason why the EM120 went eppy. Worried that running in calculated will upset the 2.4 second ping rate.
06/10/2008 11:13	At 180 m the EM120 stopped pinging in sequence. So switched to calculated
06/10/2008 09:51	ADCP started to miss a ping every so ofter - query as to whether this was as a result of increased depth and processing or whether just handed noticed when se
06/10/2008 09:38	Varied EK60 ping rate to increase sample rate whilst still allowing ADCP to ping on every command. See photo of SSU pings for what it should look like
06/10/2008 08:34	ADCP to 500m. EM120 showing noise so played around with turning instruments on and off. Now finished no visible interference from other instruments
06/10/2008 08:25	Slowing EK60 to allow ADCP more time to ping.
06/10/2008 08:20	Trying all instruments together heading off shelf
05/10/2008 17:59	Collecting bottom tracking for calibration JR218_0.txt
05/10/2008 10:55	Create file of ADCP to test whether it can be calibrated in this setup. Bottom tracking on
04/10/2008 17:45	Weather crap
04/10/2008 15:05	ADCP on bottom tracking mode JR218_4
04/10/2008 15:01	Added EM 120 as master system into SSU.ini file - now EA reads correctly
04/10/2008 14:42	EM ok
04/10/2008 14:37	checking EA depth versus EM - no obvious discrepancy
04/10/2008 12:39	still delay in EA600 causing
04/10/2008 12:30	EM120 was delaying its pulse, showing up only on the EA600 making wrong depth
04/10/2008 11:50	ADCP pinging in bottom track on a 4 second rate, ek60 on 2 second

Appendix 1

Backup of the Simrad Synchronisation Unit Configuration

4/10/2008 – Ben Tullis – btull@bas.ac.uk

Prior to modification of the SSU configuration, a backup was taken of the existing configuration.

The method used to perform this backup follows.

1. Closed the SSU software by pressing the Escape key
2. Restarted the SSU machine by pressing control, alt and delete
3. After the BIOS initialisation a boot menu was displayed for five seconds.
4. The second entry on this menu, labelled FTP server was selected.
5. The machine then proceeds to load a TCP/IP stack, configure an IP address of 10.104.2.233 and start an ftp server in the foreground.
6. An ftp client on a Windows XP host was used to connect to the service, by using the DNS name of ssu.jcr.nerc-bas.ac.uk
7. Changed directory to the SSU program location by typing cd \ssu
8. Listed the contents of the directory by typing ls
9. Retrieved the files individually by typing “get” followed by each filename. i.e. get ssu.ini, get ssu.exe
10. Once all of the files had been retrieved, a copy was placed on the ship’s NetWare server jrna.jcr.nerc-bas.ac.uk in the directory: O:\ICT\ssu software\SSU Configuration Backup - 04-10-2008\ssu

Ordinarily with an FTP client, the command mget * would retrieve all files, obviating the need to retrieve each file individually. This particular FTP server did not seem to respond well to this command, so the get command was used.

In order to restore the backed-up files, one would use a similar process but use the put command to copy files from the local machine to the SSU.

Once the backup was verified, the files were edited in-place, using the DOS edit command.

Appendix 2

Editing SSU.ini files and available .ini files

This document should be used alongside the SSU manual as there are components in each that would be helpful. A number of SSU.ini files have been written related to this manual (SSU_EK60.ini, SSU_ADCP.ini). To load a configuration, overwrite the SSU.ini file with the relevant ini file – e.g. c:\ copy SSU_EK60.ini SSU.ini. If you are going to edit a SSU.ini file, please create a backup of the SSU.

The first component of the SSU script sets up what modes are possible from that script

[General]	
Modes=EM&EA&EK&AD TO,EM&EA EK&AD, EA&EM EK&AD, EM&EA AD&EK	Editable titles of modes (have to be model names)
Resolution=20	Time (secs) for display
DepthMenu=1	1 enables the depth menu
DepthMode=0	0 automatic depth
ManualDepth=1000	Manual depth input default
DepthDataPort=2003	UDP port to get depth from
Systems=EM 120, EA 600,EK 60,TOPAS,ADCP	What acoustic systems are controlled

The second component is a system section which is instrument specific and hardware setups – DO NOT alter these unless you are familiar with what you are doing as they can alter the voltage of trigger sent to the instrument.

[EM 120]	System to programme
ModelType=S_SIGNAL	Type of system
TriggerOutCh=1	Output channel from SSU
TriggerOutActiveHigh=0	Refer to manual – related to trigger voltage
TriggerInCh=1	Sets input trigger channel to SSU
TriggerInActiveHigh=0	Positive/negative trigger (see manual)
FinishCh=2	Channel to return finish signal
FinishActiveHigh=1	See manual – related to trigger voltage
Network=0	System not connected to network
ProcessTime=0	Decides whether percenttimeaddon menu displayed
Multipulse=0	Enables multipulse option
MaxTimeBeforeTriggerAnswer=300	Maximum wait time for trigger to answer* (ms)
SignalProcessTime=0	Adds time for signal processing to trigger

* default value for MaxTimeBeforeTriggerAnswer is 20 ms (this is the value for ADCP). The EA and EK need 0. The EM120 requires at least 200 ms according to Kongsberg as it needs to calculate pitch and yaw stabilisation constants before triggering.

The third component is software related and can be changed, altering groupings of instruments and their triggering sequences.

[EM&EA&EK&AD TO]	Grouping in the SSU (has to be same as mode title)
Groups=EM EA EK ADCP,TOPAS	Instruments and their grouping (separated by commas)
TriggerSequence=0,1	Triggering sequence (e.g. 0 = group EM EA EK ADCP), up to 64 triggering sequences can be put in with repetitions

The fourth component is a system section and software related. It sets the master system (important where there is a delay in transmitting from the trigger signal, as in the case of the EM120) and various default settings.

[EM&EA&EK&AD TO+EM EA EK ADCP]	Identifies which group you are discussing in the section
MasterSystem=EM 120	Defines the master system

RepeatCount=1 No of times group are triggered in the sequence (not used!)
Systems=EM 120,EA 600,EK 60,ADCP Systems in the group

[EM&EA&EK&AD TO+TOPAS]
MasterSystem=
RepeatCount=1
Systems=TOPAS

The fifth component sets specific constants for specific instruments
[EM&EA&EK&AD TO+EM EA EK ADCP+EM 120] Identifies which instrument in the group to set
ModelType=EM 120 Identifies model
Trigger=0 Sets trigger off at start up
TimeUsage=1 Default time usage is calculated
FixedTime=1000 Fixed time default is 1000ms

For bizarre reason it is important to write AD or ADCP in the right place! Happy fiddling. Below are the two ini files written for ADCP and EK60 work with swath

SSU_EK60.ini

[General]
Modes=EM&EA&EK&AD TO,EM&EA EK&AD,EA&EM EK&AD,EM&EA AD&EK
Resolution=20
DepthMenu=1
DepthMode=0
ManualDepth=1000
DepthDataPort=2003
Systems=EM 120,EA 600,EK 60,TOPAS,ADCP

[EM 120]
ModelType=S_SIGNAL
TriggerOutCh=1
TriggerOutActiveHigh=0
TriggerInCh=1
TriggerInActiveHigh=0
FinishCh=2
FinishActiveHigh=1
Network=0
ProcessTime=0
Multipulse=0
MaxTimeBeforeTriggerAnswer=300
SignalProcessTime=0

[EA 600]
ModelType=S_SIGNAL
TriggerOutCh=13
TriggerOutActiveHigh=0
TriggerInCh=13
TriggerInActiveHigh=1
FinishCh=14
FinishActiveHigh=1
OnLevelCh=15
OnLevelActiveHigh=1
Network=0
ProcessTime=0
Multipulse=0
MaxTimeBeforeTriggerAnswer=0

SignalProcessTime=0

[EK 60]
ModelType=S_SIGNAL
TriggerOutCh=10
TriggerOutActiveHigh=0
TriggerInCh=10
TriggerInActiveHigh=1
FinishCh=11
FinishActiveHigh=1
OnLevelCh=12
OnLevelActiveHigh=1
Network=0
ProcessTime=0
Multipulse=0
MaxTimeBeforeTriggerAnswer=0
SignalProcessTime=0

[TOPAS]
ModelType=TOPAS
TriggerOutCh=4
TriggerOutActiveHigh=0
TriggerInCh=4
TriggerInActiveHigh=1
Network=0
ProcessTime=1
Multipulse=1
MaxTimeBeforeTriggerAnswer=85
SignalProcessTime=0

[ADCP]
ModelType=ADCP
TriggerOutCh=9
TriggerOutActiveHigh=0
TriggerInCh=9
TriggerInActiveHigh=1
Network=0
ProcessTime=0
Multipulse=0
MaxTimeBeforeTriggerAnswer=20
SignalProcessTime=0

[EM&EA&EK&AD TO]
Groups=EM EA EK ADCP,TOPAS
TriggerSequence=0,1

[EM&EA&EK&AD TO+EM EA EK ADCP]
MasterSystem=EM 120
RepeatCount=1
Systems=EM 120,EA 600,EK 60,ADCP

[EM&EA&EK&AD TO+TOPAS]
MasterSystem=
RepeatCount=1
Systems=TOPAS

[EM&EA&EK&AD TO+EM EA EK ADCP+EM 120]
ModelType=EM 120
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA&EK&AD TO+EM EA EK ADCP+EK 60]
ModelType=EK 60
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA&EK&AD TO+EM EA EK ADCP+ADCP]
ModelType=ADCP
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA&EK&AD TO+EM EA EK ADCP+EA 600]
ModelType=EA 600
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA&EK&AD TO+TOPAS+TOPAS]
ModelType=TOPAS
Trigger=0
TimeUsage=1
FixedTime=1000
MultipulseEnabled=0
MultipulseInterval=1000
PercentTimeAddon=100

[EM&EA EK&AD]
Groups=EM EA,EK ADCP
TriggerSequence=0,1,1,1,1,1

[EM&EA EK&AD+EM EA]
MasterSystem=EM 120
RepeatCount=1
Systems=EM 120,EA 600

[EM&EA EK&AD+EK ADCP]
MasterSystem=
RepeatCount=1
Systems=EK 60, ADCP

[EM&EA EK&AD+EM EA+EM 120]
ModelType=EM 120
Trigger=1
TimeUsage=1
FixedTime=500

[EM&EA EK&AD+EM EA+EA 600]

ModelType=EA 600
Trigger=1
TimeUsage=2
FixedTime=500

[EM&EA EK&AD+EK ADCP+EK 60]
ModelType=EK 60
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA EK&AD+EK ADCP+ADCP]
ModelType=ADCP
Trigger=0
TimeUsage=1
FixedTime=1000

[EA&EM EK&AD]
Groups=EA EM,EK ADCP
TriggerSequence=0,1,1,1,1,1,1,1,1,1

[EA&EM EK&AD+ EA EM]
MasterSystem=EM 120
RepeatCount=1
Systems=EM 120,EA 600

[EA&EM EK&AD+EK ADCP]
MasterSystem=
RepeatCount=1
Systems=EK 60, ADCP

[EA&EM EK&AD+ EA EM +EM 120]
ModelType=EM 120
Trigger=1
TimeUsage=1
FixedTime=500

[EA&EM EK&AD+ EA EM +EA 600]
ModelType=EA 600
Trigger=1
TimeUsage=2
FixedTime=500

[EA&EM EK&AD+EK ADCP+EK 60]
ModelType=EK 60
Trigger=0
TimeUsage=1
FixedTime=1000

[EA&EM EK&AD+EK ADCP+ADCP]
ModelType=ADCP
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA AD&EK]
Groups=EM EA, ADCP EK
TriggerSequence=0,1,1,1,1,1,1,1,1,1,1,1,1,1,1

[EM&EA AD&EK +EM EA]
MasterSystem=EM 120
RepeatCount=1
Systems=EM 120,EA 600

[EM&EA AD&EK + ADCP EK]
MasterSystem=
RepeatCount=1
Systems=EK 60, ADCP

[EM&EA AD&EK +EM EA+EM 120]
ModelType=EM 120
Trigger=1
TimeUsage=1
FixedTime=500

[EM&EA AD&EK +EM EA+EA 600]
ModelType=EA 600
Trigger=1
TimeUsage=2
FixedTime=500

[EM&EA AD&EK +ADCP EK+EK 60]
ModelType=EK 60
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA AD&EK +ADCP EK+ADCP]
ModelType=ADCP
Trigger=0
TimeUsage=1
FixedTime=1000

SSU_ADCP.ini
[General]
Modes=EM&EA&EK&AD TO,EM&EA EK&AD,EA&EM EK&AD,EM&EA AD&EK
Resolution=20
DepthMenu=1
DepthMode=0
ManualDepth=1000
DepthDataPort=2003
Systems=EM 120,EA 600,EK 60,TOPAS,ADCP

[EM 120]
ModelType=S_SIGNAL
TriggerOutCh=1
TriggerOutActiveHigh=0
TriggerInCh=1
TriggerInActiveHigh=0
FinishCh=2

FinishActiveHigh=1
Network=0
ProcessTime=0
Multipulse=0
MaxTimeBeforeTriggerAnswer=300
SignalProcessTime=0

[EA 600]
ModelType=S_SIGNAL
TriggerOutCh=13
TriggerOutActiveHigh=0
TriggerInCh=13
TriggerInActiveHigh=1
FinishCh=14
FinishActiveHigh=1
OnLevelCh=15
OnLevelActiveHigh=1
Network=0
ProcessTime=0
Multipulse=0
MaxTimeBeforeTriggerAnswer=0
SignalProcessTime=0

[EK 60]
ModelType=S_SIGNAL
TriggerOutCh=10
TriggerOutActiveHigh=0
TriggerInCh=10
TriggerInActiveHigh=1
FinishCh=11
FinishActiveHigh=1
OnLevelCh=12
OnLevelActiveHigh=1
Network=0
ProcessTime=0
Multipulse=0
MaxTimeBeforeTriggerAnswer=0
SignalProcessTime=0

[TOPAS]
ModelType=TOPAS
TriggerOutCh=4
TriggerOutActiveHigh=0
TriggerInCh=4
TriggerInActiveHigh=1
Network=0
ProcessTime=1
Multipulse=1
MaxTimeBeforeTriggerAnswer=85
SignalProcessTime=0

[ADCP]
ModelType=ADCP
TriggerOutCh=9
TriggerOutActiveHigh=0

TriggerInCh=9
TriggerInActiveHigh=1
Network=0
ProcessTime=0
Multipulse=0
MaxTimeBeforeTriggerAnswer=20
SignalProcessTime=0

[EM&EA&EK&AD TO]
Groups=EM EA EK ADCP,TOPAS
TriggerSequence=0,1

[EM&EA&EK&AD TO+EM EA EK ADCP]
MasterSystem=EM 120
RepeatCount=1
Systems=EM 120,EA 600,EK 60,ADCP

[EM&EA&EK&AD TO+TOPAS]
MasterSystem=
RepeatCount=1
Systems=TOPAS

[EM&EA&EK&AD TO+EM EA EK ADCP+EM 120]
ModelType=EM 120
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA&EK&AD TO+EM EA EK ADCP+EK 60]
ModelType=EK 60
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA&EK&AD TO+EM EA EK ADCP+ADCP]
ModelType=ADCP
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA&EK&AD TO+EM EA EK ADCP+EA 600]
ModelType=EA 600
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA&EK&AD TO+TOPAS+TOPAS]
ModelType=TOPAS
Trigger=0
TimeUsage=1
FixedTime=1000
MultipulseEnabled=0
MultipulseInterval=1000
PercentTimeAddon=100

[EM&EA EK&AD]
Groups=EM EA,EK ADCP
TriggerSequence=0,1,1,1

[EM&EA EK&AD+EM EA]
MasterSystem=EM 120
RepeatCount=1
Systems=EM 120,EA 600

[EM&EA EK&AD+EK ADCP]
MasterSystem=
RepeatCount=1
Systems=EK 60, ADCP

[EM&EA EK&AD+EM EA+EM 120]
ModelType=EM 120
Trigger=1
TimeUsage=1
FixedTime=500

[EM&EA EK&AD+EM EA+EA 600]
ModelType=EA 600
Trigger=1
TimeUsage=2
FixedTime=500

[EM&EA EK&AD+EK ADCP+EK 60]
ModelType=EK 60
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA EK&AD+EK ADCP+ADCP]
ModelType=ADCP
Trigger=0
TimeUsage=1
FixedTime=1000

[EA&EM EK&AD]
Groups=EA EM,EK ADCP
TriggerSequence=0,1,1,1,1,1,1,1

[EA&EM EK&AD+ EA EM]
MasterSystem=EM 120
RepeatCount=1
Systems=EM 120,EA 600

[EA&EM EK&AD+EK ADCP]
MasterSystem=
RepeatCount=1
Systems=EK 60, ADCP

[EA&EM EK&AD+ EA EM +EM 120]
ModelType=EM 120
Trigger=1

TimeUsage=1
FixedTime=500

[EA&EM EK&AD+ EA EM +EA 600]
ModelType=EA 600
Trigger=1
TimeUsage=2
FixedTime=500

[EA&EM EK&AD+EK ADCP+EK 60]
ModelType=EK 60
Trigger=0
TimeUsage=1
FixedTime=1000

[EA&EM EK&AD+EK ADCP+ADCP]
ModelType=ADCP
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA AD&EK]
Groups=EM EA, ADCP EK
TriggerSequence=0,1,1,1,1,1,1,1,1,1

[EM&EA AD&EK +EM EA]
MasterSystem=EM 120
RepeatCount=1
Systems=EM 120,EA 600

[EM&EA AD&EK + ADCP EK]
MasterSystem=
RepeatCount=1
Systems=EK 60, ADCP

[EM&EA AD&EK +EM EA+EM 120]
ModelType=EM 120
Trigger=1
TimeUsage=1
FixedTime=500

[EM&EA AD&EK +EM EA+EA 600]
ModelType=EA 600
Trigger=1
TimeUsage=2
FixedTime=500

[EM&EA AD&EK +ADCP EK+EK 60]
ModelType=EK 60
Trigger=0
TimeUsage=1
FixedTime=1000

[EM&EA AD&EK +ADCP EK+ADCP]
ModelType=ADCP

Trigger=0
TimeUsage=1
FixedTime=1000

Appendix 3

Operating the SSU

Turning on

The SSU program is started up by typing SSU at the DOS prompt. This loads an SSU.ini file in which groups of instruments and triggering sequences can be determined. For methods of altering this please talk to your local ITS/ETS support person and appendix 2 of this report.

Navigation

The SSU settings are set by using the arrowed control handset next to the SSU monitor. The settings are navigated using the forward/backward and up/down arrow buttons. Pressing the forward arrow selects and accepts the relevant option. So if you press the forward arrow button by mistake the you need to go back to change it to its original settings. Every time a settings is changed you go back to the start menu.

Operation

The first option to select is the “mode” – these are the groups of instruments and their trigger sequences. The current SSU.ini file loaded (a copy of SSU_EK60.ini) has four modes.

EM&EA&EK&AD TO	EM, EA, EK and ADCP trigger simultaneously
EM&EA EK&AD	EM&EA trigger together, EK and ADCP together. There is one EM&EA trigger for every five EK and ADCP triggers
EA&EM EK&AD	EM&EA trigger together, EK and ADCP together. There is one EM&EA trigger for every ten EK and ADCP triggers
EM&EA AD&EK	EM&EA trigger together, EK and ADCP together. There is one EM&EA trigger for every fifteen EK and ADCP triggers

Using the forward arrow accept the relevant mode. You are now required to set each instrument up with the following options.

To trigger a system, or to start it triggering.

1) Select the acoustic system in the appropriate group sub-menu. Access the system by pressing forward on the joystick
2) On the sub-menu, select trigger, and press forwards with the joystick to accept trigger on (or off)

To set time-usage for a system

1) Select the acoustic system in the appropriate group sub-menu. Access the system by pressing forward on the joystick.
2) On the sub-menu Time Usage, select Tx pulse, Calculated or Fixed time by pressing forward on the joystick
    a. Tx pulse – The SSU holds control of the system for the duration of the transmission pulse, it does not wait for the system to finish listening
    b. Calculated – The SSU holds control of the system for the duration of the transmission pulse AND the listening waiting period.
    c. Fixed time – The SSU holds control of the system for a defined period of time. This should be at least the duration of the transmission pulse and is manually set by the user.

Appendix 4

EA600 – User settings

This user guide is an abbreviation of a guide provided by AME which can be found next to the EA600 monitor display in the UIC. It details the most common settings that need to be changed when on a typical acoustics cruise. You should always inform the bridge when changing the EA600 settings even when you have control ('Scroll lock' light is not illuminated).

Internal/External Trigger – ***File -> Operation -> tick/untick Extern Trig***

With external trigger switched off, the EA600 operates on its own with no input from the SSU. This is the standard mode when the ship is in very shallow water. When external trigger is switched on, the EA600 will ping when told to do so by the SSU according to the current rules in place at the time.

Active/Passive mode – ***Right click on '12kHz -> (Mode)***

In active mode, the EA600 transmits and listens to its own pulse. This is standard mode when in very shallow water with an internal trigger but can equally be used in waters less than 1000m when in external trigger mode as long as the SSU is set up to avoid interference with other acoustic systems. Alternatively, the EA600 can be set in passive mode and will listen for the centre beam return of the EM120. This requires that EA600 is on external trigger and that the EM120 is pinging.

Bottom detection range – ***Right click on depth reading at top of screen***

This controls the depth window within which the EA600 will try to resolve the bottom depth. The minimum/maximum depths should be set to an appropriate range given the local seabed variation. In normal operations, the officer on watch will monitor the depth range and adjust accordingly. Beware that if the range is not set correctly (i.e. the depth is outside the range) then depth reading will be incorrect.

Echogram range – ***Right click on the area to the right of the echogram***

Changing these values alters the view on screen, not how the EA600 collects data. Should be kept to the same values as the bottom detection range.

Gain setting – ***Right click on the coloured panel in the top right hand corner***

The higher the gain the more detail will be shown in the water column. Increase the gain if the bottom echo is very weak and decrease if there is too much detail in the water column itself. Time variable gain can also be changed by right clicking on the echogram. The default value of 20log(r) can be changed to 30log(r) in shallow water when the EA600 is running in passive mode to allow easier visual detection of the bottom.

Appendix 5

EM120 – The Basics Cue Card™

This cue card should help a non-expert user to start the EM120 and run it in an opportunistic fashion. It describes the important settings that can be changed and a few of the common problems.

Ready
Firstly the hardware located on the tween deck needs to be switched on. This is best left to the local IT/Engineering person on board. A simple on/off button can be found above the EM120 monitor in the UIC. This should be turned to on.

The EM120 workstation needs logging onto (user = em120, see IT for password) and the user interface can be started by clicking the middle mouse button and selecting 'Start Operator Interface'. There may well be flashing red errors messages at this point. Before breaking down in tears, try quitting the application and starting it again – it sometimes works, otherwise inform IT.

The workspaces used most often are Survey and MBES. Survey shows the underway data acquisition in graphical form while the MBES workspace shows the current settings that can be edited.

Steady
At the start of a cruise select the new survey option. This prompts for a survey name – any can be chosen but the usual advice is the cruise number, an underscore and then a letter or number (i.e. jr218_a). A projection is then asked for. This does not affect how the data is collected, only how it displays in the underway map view. Mercator_60_degrees is fine for almost all surveys.

The line number will start at 1. These correspond to the hour files that the swath survey is split up into. A new line (hour file) can be started at any time by pressing the line button.

Click on the MBES workspace button to see the most common settings. Most of the defaults can be left alone but take note of the following

Max Port/Starboard angle – This determines how far the beams fan out. The default setting for an opportunistic cruise is 60 degrees either side. These can be reduced in bad weather to reduce the noise in the outer beams or increased in calm weather to increase the coverage. The normal working range is about 50 – 70 degrees.
Min/Max depth – Make sure that these are set to encompass all the potential depths that will be encountered on a cruise especially if the system will not be monitored often. The depth range can be narrowed to help the swath lock onto the correct seabed in rough weather. The 'Force depth' button allows the user to put in a single value that the EM120 can use to help locate a lost bottom. Not setting the max depth deep enough is the easiest way to lose data.
Sound speed – The sound velocity profile used by the EM120 is very important and the steps to change it when needed are described in the EM120 svp cue card.

Go
Assuming that the SSU is setup in the required mode (see the SSU cue card), then starting the EM120 is a case of hitting the active button. Let the EM120 find the seabed and get a number of good returns before hitting the logging button. Hooray, you're a swath operator and you're very likely seeing features on the sea floor that no-one else has.

Underway
The multibeam system will run on its own and collect reasonable data for long periods of time but checking it on a daily basis (or more often) is beneficial.

Check that data is still being recorded and that EM120 trigger pulses are being registered on the SSU.
Look at how noisy the ping traces are – if the weather is bad, the beam angles can be brought in.
Check to see if the sound velocity profile needs changing (see the EM120 svp cue card).

Check that the depth range is still correct and will cover the upcoming period of work.
Stop logging the swath if the ship is at station for a long period of time, especially at base calls. This prevents unnecessary processing.
Stop logging and turn the swath to off when instructed by the officer on watch, usually when in very shallow water.
Another survey can be started by stopping logging and selecting a new survey. Follow the same steps as for the start of the cruise. A new survey name can be useful to split a long cruise into logical segments.

Help, the swath is dead

Try the following if things look bad.

If nothing is showing on the survey display, always check the depth window first and adjust if necessary. Also use the depth settings if the swath has locked onto a false bottom. Check the EA500 or the navigation charts to determine what the depth should be approximately.
Stop logging and turn the swath to off. Turn the swath to active and often the EM120 will come back to life. Remember to start logging again.
Check the SSU and the other acoustic instruments. Occasionally it might need the trigger stopping and starting on the SSU.
Occasionally closing the survey and ping display windows and restarting them can unfreeze the system. After that try quitting the whole operator interface and restarting. I this doesn't fix it, then try your IT guy.

Appendix 6

EK60 Operation and settings

The core of EK60 operations is undertaken using the two computers in the UIC, labelled EK60 Main Processor (APC10) and EK60 Workstation (JCR-EK60WS-D1). The EK60 Main Processor runs the EK60 itself and it is important that this computer is not used for anything else. The EK60 Workstation is creating the backup log files and likewise should not be used unnecessarily.

Step 1
Switch on the EK60 workstation. Log on using **EK60** as the user and **krillfinder** as the password. All acoustic data is logged to a central storage area (U:\ drive), if you cannot see the U:\ drive on this computer please contact your onboard IT support person to correct this. There is a directory containing an excel spreadsheet on which all the EK60 settings can be recorded (c:\cue card\EK60 settings.xls).

EK60 operation
Switch the EK60 GPTs on using the switch (labelled EK60 remote on/off switch) on the wall to the left of the EK60 Main Processor PC.
Switch on the EK60 by turning on the EK60 Main Processor (unscrew the plate on the front of the blue machine to the bottom left of the EK60 Main Processor monitor).
Please log on to the computer using the login **EK60** and password **krillfinder**. A programme called K9nt should start up automatically. Check that a time broadcast arrives in the window associated with this programme, if it does not please contact your local friendly IT support to ask them to rectify this. **DO NOT CLOSE THIS PROGRAMME JUST MINIMISE IT**.
Run the **ER60** software (icon on desktop), choose most recent state, and the main ER60 screen (empty) should come up.
2) Check settings of the EK60 and record on excel spreadsheet found on EK60 Workstation
a) Click ***Operation > Normal.*** Check the following and when/if the same as below click ***ok***. You should see the following settings – if not please change to the following settings

Channel	Mode	Pulse duration/Sample interval/Bandwidth	Power	Depth (m)
GPT 38 kHz 009072033fa5* 1 ES38	Active	1024us / 256us / 2425Hz	2000 W	0.00
GPT 120 kHz 00907203422d* 1 ES120-7	Active	1024us / 256us / 3026Hz	500 W	0.00
GPT 200 kHz 009072033f91* 1 ES200-7	Active	1024us / 256us / 3088Hz	300 W	0.00

* these are the serial numbers of the installed GPTs – please note these in the excel spreadsheet. If you have to change a GPT please note the time and date of the change in the event log and the new serial number.

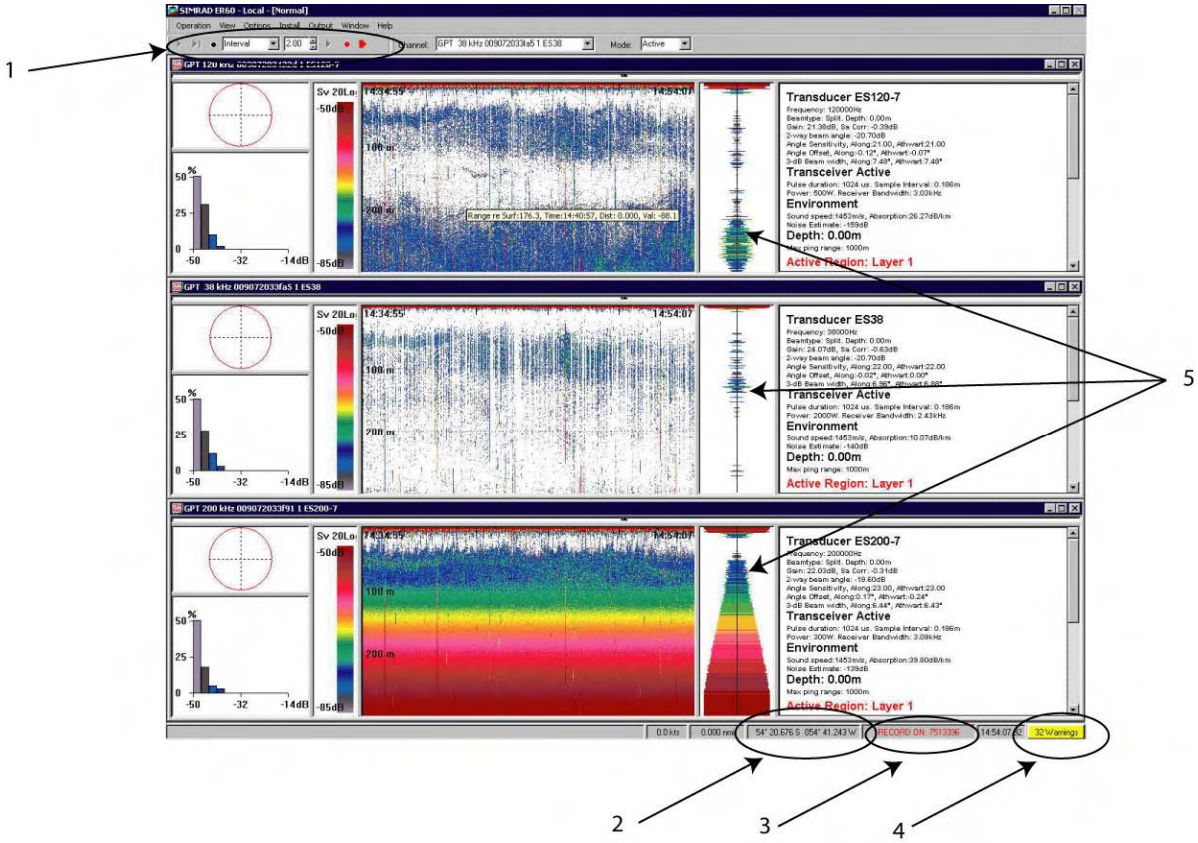
On clicking ok 3 windows should appear (38, 120 and 200 – all should be visible) – although they may not show anything depending on whether the EK60 is actively pinging.
b) Click ***Install > environment*** then check and record the settings for each frequency > click ***ok***
The conditions should be Seawater. Please record the temperature, salinity and sound speed that are being used (you will have to manually enter the 3 frequency settings to check the data), then record this in the excel spreadsheet.
c) Click ***Operation > ping control***

Operation should show only the start (if echosounder not pinging) or stop (if echosounder already pinging) option, Set ping mode to interval (2.00 is default value to use) and, for the moment, make sure the incoming and outgoing trigger boxes are empty (unticked). Click **START**. The EK60 should now commence displaying data. Then click close window.

CHECK WHERE THE RAW DATA IS BEING SAVED TO AND IN WHAT FORM
d) Click ***Output > File***:
directory tab: use browse to choose the correct folder to log the data to,
i.e. ***U:/data/ek60 raw data/JR$$$/*** etc.
raw data tab: change file name prefix should be JR$$$ ($$$ = cruise no.)
Range (m) = 1000 (this is important!)
File size Max vessel distance (nmi) = 0
Max file size (Mb) = 25
TICK Save raw data (***untick at end of transect to stop recording data***)
Processed data tab: leave box un-ticked.
Click ***ok***

The following will show if all is working correctly. See below for picture accompaniment.

1) Ping control area (on/off) - the dot (stop) should be black, the play and pause should be grey (equals echosounder pinging and on). Interval = 2.00. The red buttons are the record control. The little play button (on the left of the three) is greyed out, the dot (stop) should be red, and the big play button should be red.
2) These are lat/long positions and should be changing as you move! If not there may be a problem with the GPS system and you need to call the IT support person.
3) This is the file name being recorded and should be in red when recording. If not recording it will be in black – **this is bad if it happens during the survey!** If this occurs try redoing steps a – d above. If still happens seek help from AME and IT people and Pete or Sophie if necessary.
4) These are EK60 warnings, such as losing contact with the transducers. Do not be concerned if there are a number of warnings during the whole survey (e.g. 0 – 150), but if tens of warnings occur in a few minutes then rebooting (i.e. turning off and turning on again) the system might be necessary or there may be a network problem.
5) Single ping display. This panel shows the results from each single ping. It should change every two seconds (since that is the desired ping rate), and is a good indication that the echosounder is working.
6) If you get a 'cannot meet ping interval' error, ensure that the bottom detection is set to zero in each of the three windows. Right click at the top of the echogram (near to 0.00m), click 'bottom detection' and set to zero.



Finally, record the Gain, Sa correction, 2-way beam angle, Angle sensitivity along and athwart, Angle offset along and athwart, 3-dB beamwidth along and athwart and the absorption coefficient for each frequency in the excel spreadsheet provided. These are found in the data to the right of the echogram. If not visible, right click on echogram > configure window > check "Numerical" box.

Echolog setup *this only works if you have an Echoview dongle*
Echolog runs on the EK60 Workstation, to the right of the EK60 main processor.
Click ***Start > programs > Sonardata 4 > Echolog 60***
Right click on top left corner (Echoview icon) for options (there are no obvious menu options) go to

Settings: EK60 survey folder = ***U:\data\EK60 raw data\JR$$$*** (etc.), i.e. the folder that the ER60 software is saving to

Folder check interval (ms)	= 250
Echodepth broadcast interval (ms)	= 500
Live viewing broadcast interval (seconds)	= 10
Warn when hard disk has less than (MB)	= 50
Warn when hard disk has less than (minutes)	= 60
Equipment name	= JCR-EK60WS-D1
Warn if no activity (minutes)	= un-ticked

Data compression: Tick '***enable***'

Delete original files after compression	= **UN-TICKED**
Suspend when hard disk has less than (MB)	= 10

Write compressed files to folder = ***U:\data\Echolog\JR$$$*** etc.**,** i.e. the folder that mirrors where the data is saved in the EK60 raw data folder

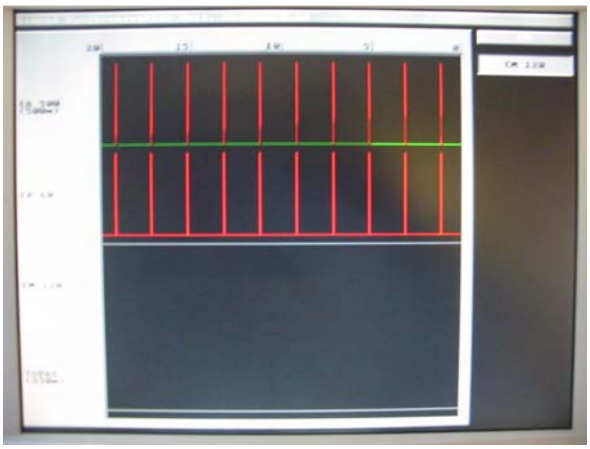
Click ***Compression settings***
Compression settings need to be set for each of the three transducers – that is Transducer 1, Transducer 2 and Transducer 3. The following are the compression settings to be used for all three frequencies.

1) Choose transducer 1 from the drop down menu
Store power data = TICKED
Start range (m) = 0
End range (m) = 300
Reduced data resolution:
Average samples where both Sv below (dB) = -80
and TS below (dB) = 20
Average samples below sounder detected bottom + offset = un-ticked
Maximum number of samples to average = 50
Split beam data = un-ticked
(All the boxes should then be greyed out)
Sounder detected bottom
Ignore bottom detection if range less than (m) = = 10
Click ***ok***
Go to transducer 2 and repeat, click ***ok***, then do the same for transducer 3. Click ***ok*** again.

If the echosounder is working Echolog should now indicate that a file is being written. The data throughput is displayed in the top-left of the menu bar. It is typically between 16 and 25 KB/s. To check that the ER60 software and the Echolog software are working correctly, file names (that are time stamped) can be viewed using the file manager window.

Now go to the EK60:
Click ***operation*** > ***ping control***
Make sure ***ping rate (interval)*** is 2 seconds
Triggering: TICK box for ***ingoing*** (It should read GPT auxiliary port.)
Click ***close***

The SSU should now look SOMETHING like this:



SSU monitor:
EA (top) + EK (below) must ping at the **same time** and must show a **red (active)** signal

EA must show a **green line (waiting)** between pings

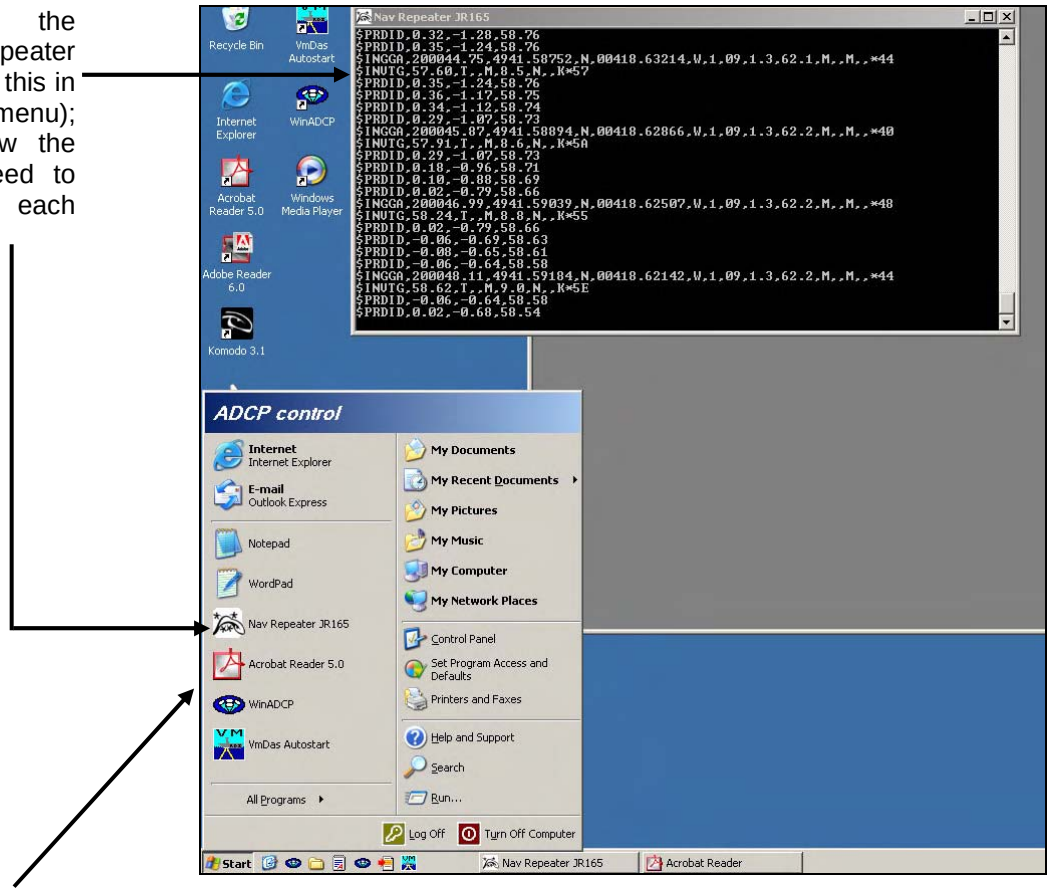
Appendix 7

JCR ADCP cue card

1. Turn ADCP on at the wall (switch above monitor labelled "ADCP Power" needs to be switched to "ON" and should light up red)

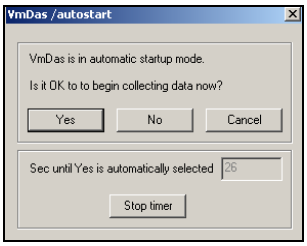
2. Check there is sufficient space on the hard drive (at least 3GB)

3. Make sure the Navigation Repeater is running (find this in the Start menu); (JR165 is now the default, no need to create for each cruise)

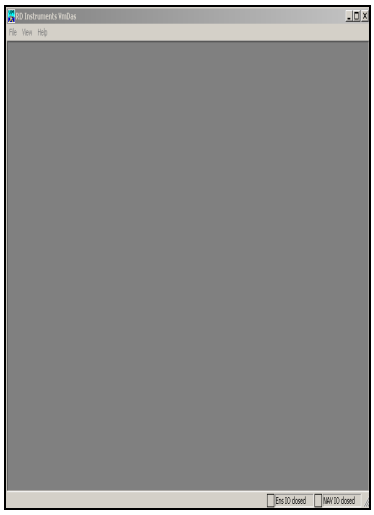


4. Run VmDas (icon on desktop and in start menu)

   If you get the following Autostart screen, click **Yes**



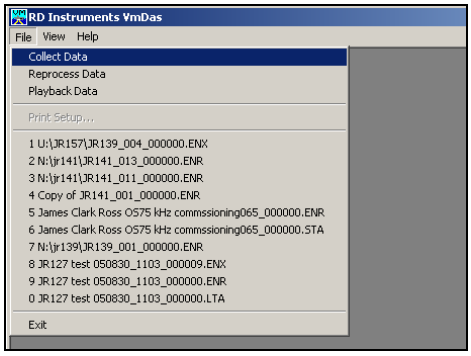
   This window should then appear.

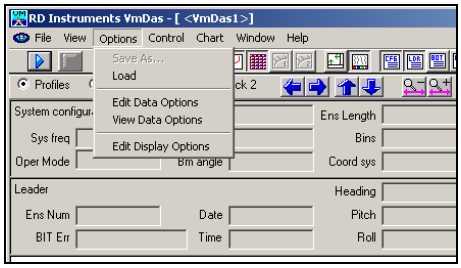


   starts the setting up to collect data)

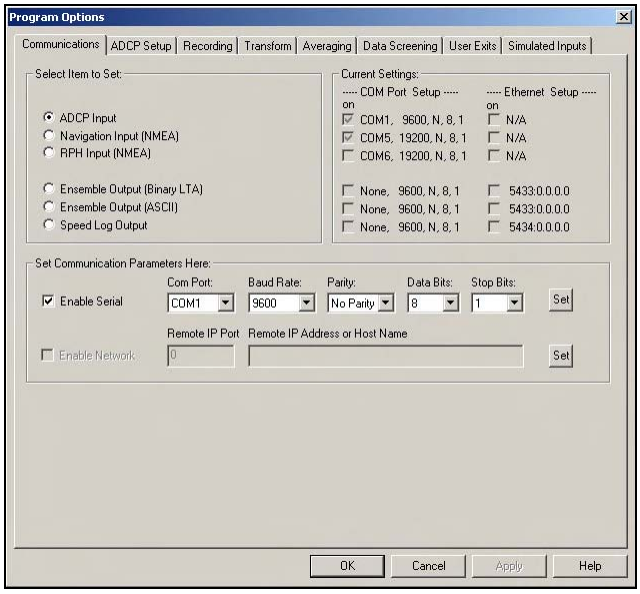
5. In the **File** menu, click on **Collect Data** (this actually

6. In the **Options** menu, select **Edit Data Options**



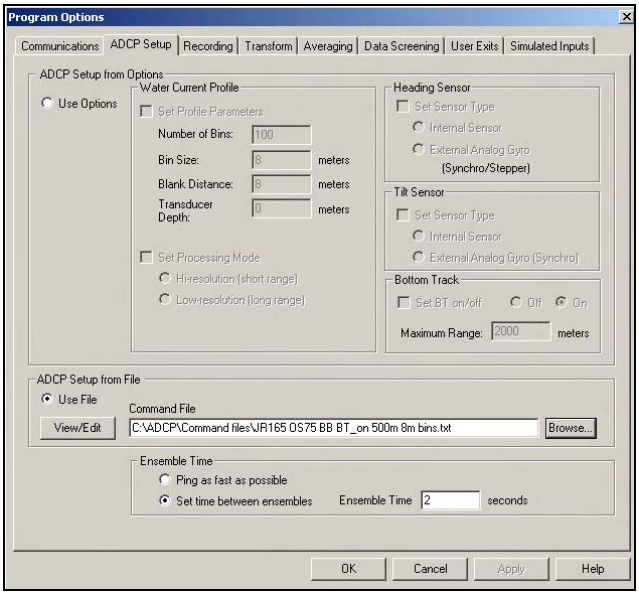


a) **Communications tab**



You shouldn't have to touch any of this… it should be set up as above.

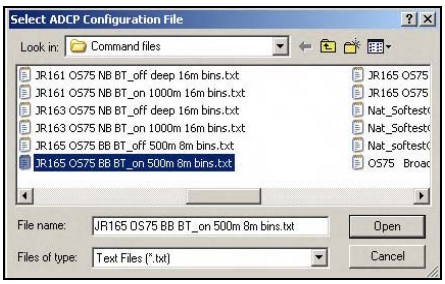
b) **ADCP Setup tab**



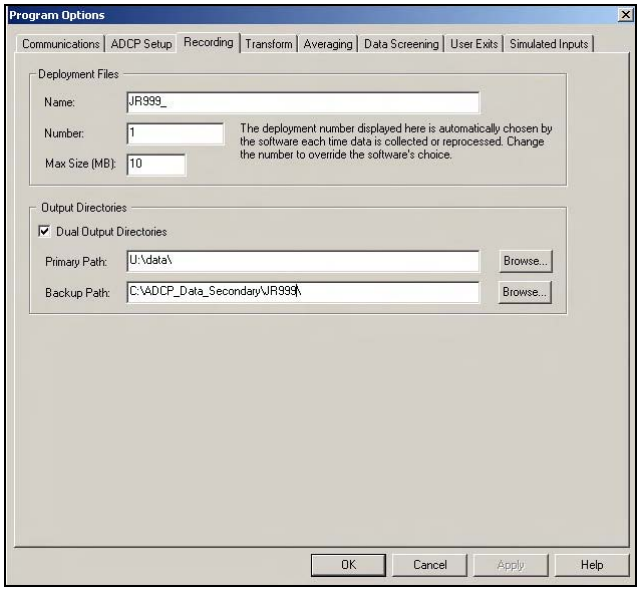
Enable ADCP Setup from File.
Set to Ping as fast as possible (not as shown).

Click or **Browse** to pick command file.

(See note at end)



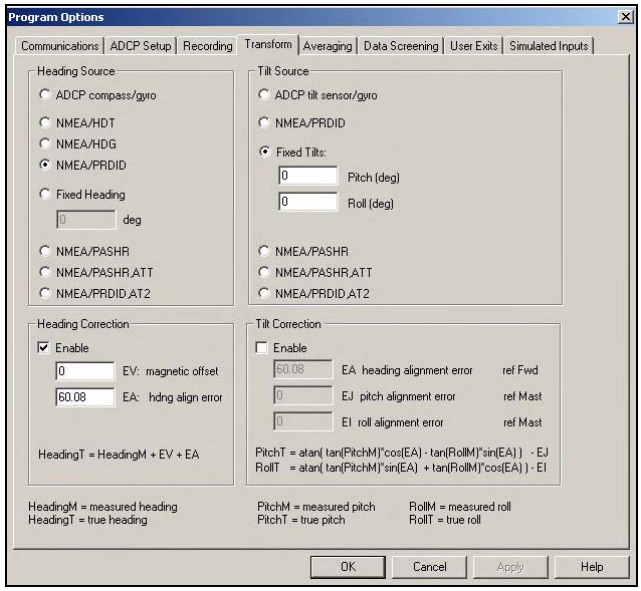
c) **Recording tab**



Name = JRNNN_ (where NNN = cruise number, e.g. JR165_)

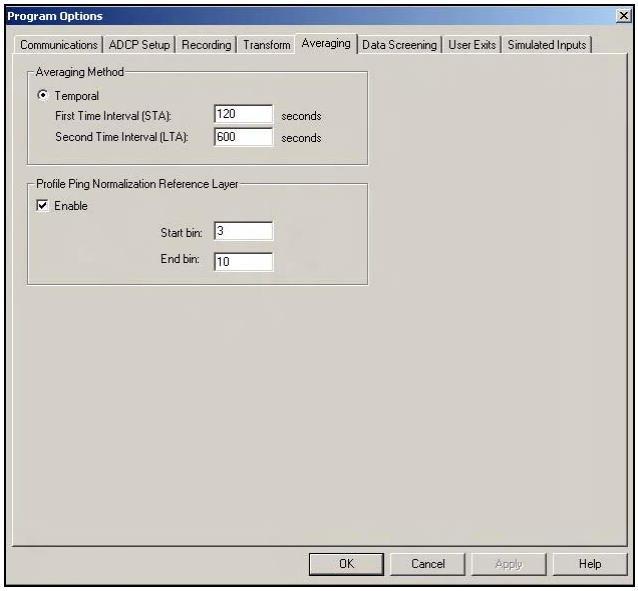
Number = 1 or 2 or ... make sure this increments since last time or you will over-write data!
Max Size = 10
Primary Path = U:\data\
Backup Path = C:\ADCP_Data_Secondary\JRNNN

d) **Transform tab**



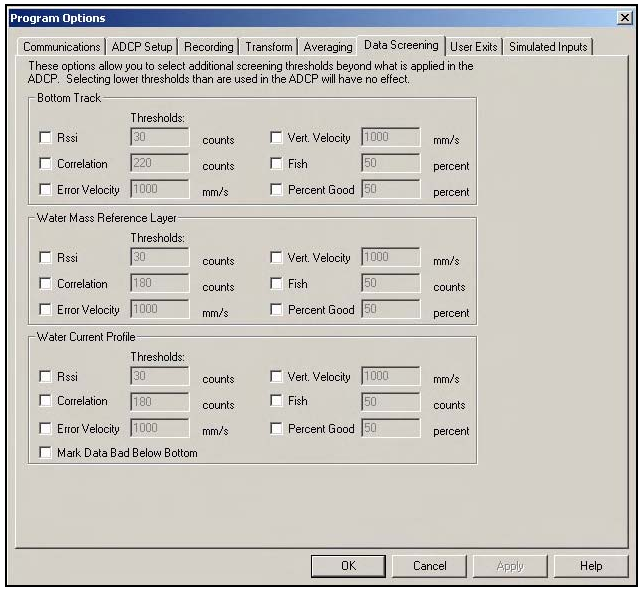
Heading Source = NMEA/PRDID
Tilt Source = Fixed Tilts (0 for both)
Heading Correction = Enable: 0 (EV), 60.08 (EA)
Tilt Correction = don't enable

e) **Averaging tab**



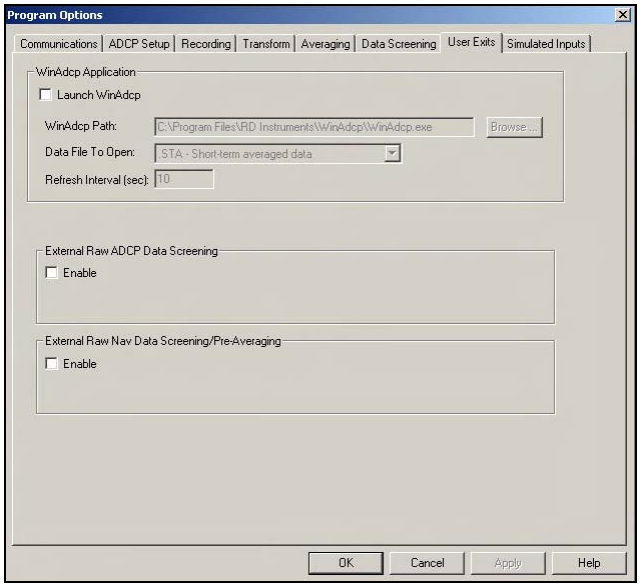
STA = 120 (for 2 minute averaged data)
LTA = 600 (for 10 minute averaged data)

f) **Data Screening tab**



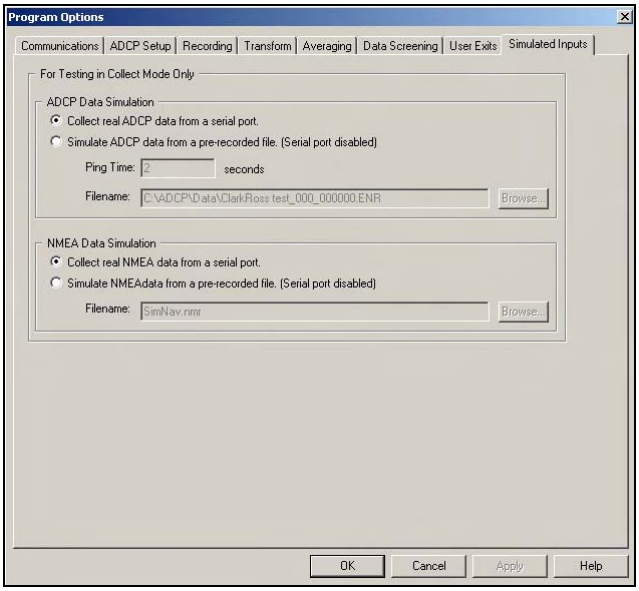
Don't touch this.

g) **User Exits tab**



Don't enable or use any of this.

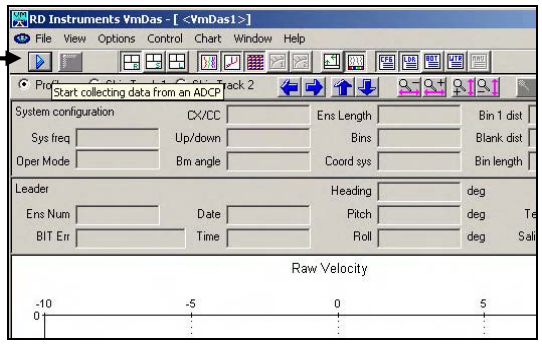
h) **Simulated Inputs tab**



Collect real ADCP data from a serial port
Collect real NMEA data from a serial port

7. To start the ADCP pinging and collecting data, click on blue arrow (in top left corner under "File" menu, looks like a "play" button), or click on **go** in the **Control** menu.

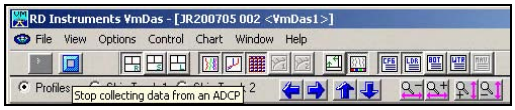
   If it is working the log screen should run through a number of commands, and eventually say something like "ADCP pinging" and then disappear and data should appear and change regularly.



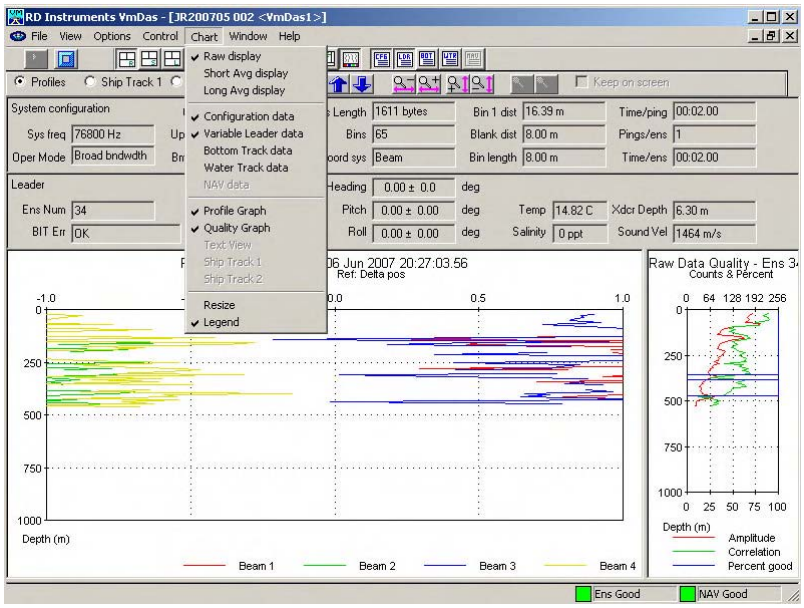
8. To stop the ADCP pinging, either

   click on **stop** in the **Control** menu

   or click on the blue square in the top left hand corner



9. To change the data display, use the **Chart** menu and/or the toggle buttons →



To find out more see the **VmDas User's Guide**, which is on the ship in both printed and electronic format.

Note on command files
Command files have been created for different scenarios - personnel on cruise, depth, need to calibrate instrument. These can be found in C:\ADCP\Command Files\SetModes

JCR_BT250.txt = 250m Bottom Track 8mBins Through SSU
JCR_BT500.txt = 500m Bottom Track 8mBins Through SSU
JCR_BT_opp.txt = 500m Bottom Track 8mBins Not Through SSU
JCR_WC_opp.txt = 800m Water Track 8mBins Not Through SSU
JCR_WC800.txt = 800m Water Track 8mBins Through SSU

Note: Bottom tracking data (BT_on) is very important for calibration purposes, but reduces the temporal resolution and does not work when ADCP is synchronised with other acoustic devices on the ship.
Note: These all use Narrowband mode, which is recommended unless there is a specific requirement for broadband, at which point you will know what you're doing anyway.

Potential Problems
The ADCP can run into problems, mostly if it does not receive a trigger from the SSU to ping, causing it to timeout. This causes a white window to appear and start scrolling. Sometimes the ADCP recovers and continues pinging, though the ensemble number may reset to 1, though the actual data file recorded is fine despite this. Other times the instrument stops recording and it should be stopped and restarted immediately. If this fails then check the SSU, it may have crashed.

Outputs
The ADCP writes a series of files to the unix drive (the primary path) and the raw data to the secondary path (sufficient to recover the data, but needs to go through VmDas again to be processed in matlab). The file types and numbering is:
JRNNN_XXX_YYYYYY.EEE
Where:
XXX is a number that increments when the data collection is stopped and restarted. The matlab processing expects this to change so data collection has to be stopped and restarted before matlab processing (as things stand with the code). This is usually done once per day.
YYYYYY is a number that increments once the file size has reached 10Mb, the matlab code scrolls through these for each XXX. Different file types (see below) have different rates of data collection so YYYYYY may be different between them. This is fine.
EEE is the file extension:
.N1R (NMEA telegram + ADCP timestamp; ASCII)
.ENR (Beam co-ordinate single-ping data; binary). These two are the raw data, saved to both disks
.VMO (VmDas configuration; ASCII)
.NMS (Navigation and attitude; binary)
.ENS (Beam co-ordinate single-ping data + NMEA data; binary)
.LOG (Log of ADCP communication and VmDas error; ASCII)
.ENX (Earth co-ordinate single-ping data; binary). This is read by matlab processing
.STA (Earth co-ordinate short-term averaged data; binary)
.LTA (Earth co-ordinate long-term averaged data; binary). This is used for google earth real time plotting

The matlab code expects the XXX number to increment so the data collection should be stopped and immediately restarted each day if the data is being processed during the cruise. The file number should be changed in OS75_JCR_JRNNN and the program run. Data can then be checked for problems or used.

Appendix 8

Communication with SIMRAD

Hi Alex, I have copied two manual pages into this mail. One page is taken from the EA instruction manual that shows the pins for where the input TrigIn (+-) signals goes (pin 13 & 25). The other page is taken from the EM120 installation manual that shows where the Trigger Out signal is available. If you connect the Trigger Out signal from EM120 transceiver into the EA GPT TrigIn the two systems will work together as long as the EA is set to External Trig mode and passive (passive means that the EA is not transmitting only receiving.

Hope this info is sufficient. Note that the signal from the EM120 is a 5V TTL.

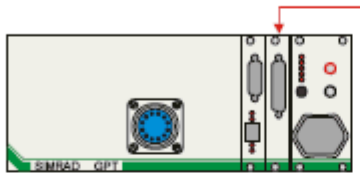
Best regards

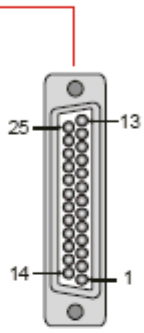
FrankW.

EA instruction manual page 123

GPT Remote synchronisation

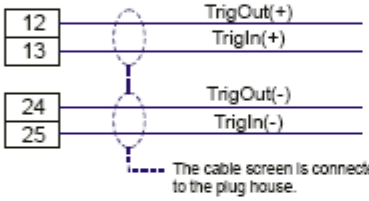
This cable is used to connect the General Purpose Transceiver (GPT) to an external system for synchronisation purposes.





Auxiliary connector (female)

GPT
25-pin D-sub connector



Several transceivers may be triggered from an external system by connecting the TrigIn pins in parallel.

W620b / Rev C	External trigger in/out

Conductors	2 x 2 x 0.22 mm2
Screen	Braided pairs and overall braided
Voltage	60 V
Max.diameter	Set by the plugs

EM120 installation manual page 63

W202

This cable connects the Transceiver Unit to a remote On/Off switch located in a Junction Box (type 212595). The same connection allows trigger output and remote control by a serial line.

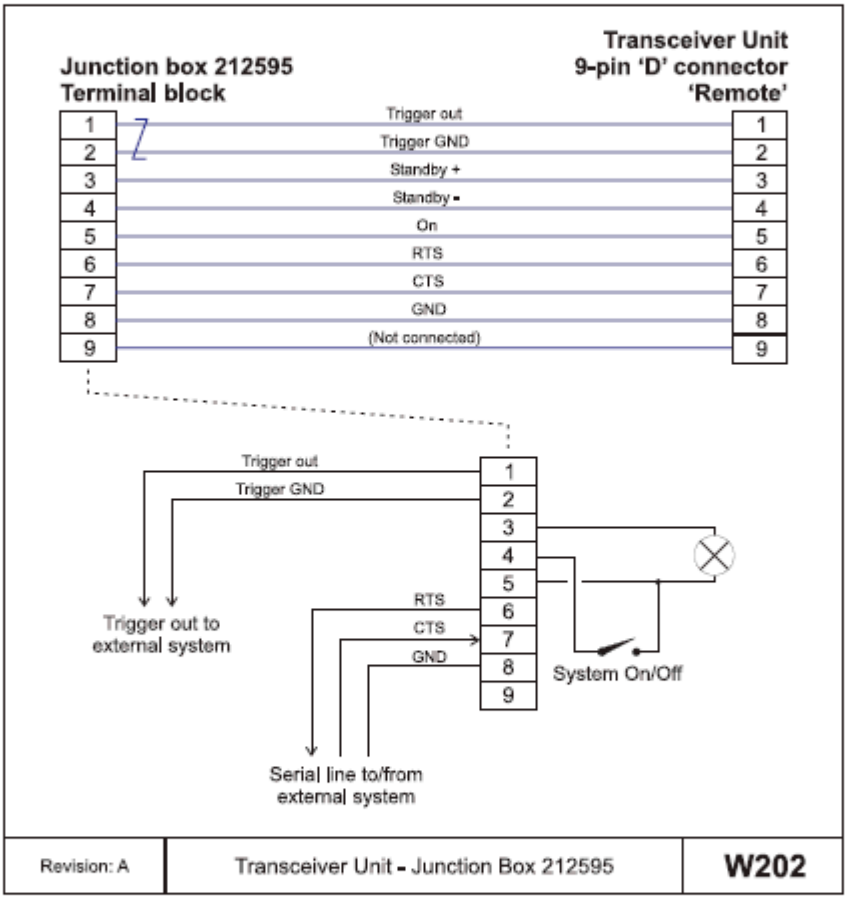


Figure 24 - W202

Conductors	5 x 2 x 0.5 mm2
Screen	Overall braided
Voltage	60V
Max.diameter	Set by the plugs

Alex Tate ajtate@bas.ac.uk

Alex Tate <ajtate@bas.ac.uk>	To	"km.support@kongsberg.com" <km.support@kongsberg.com>
07.10.2008 10:53	cc	
	Subject	Re: Several SSU related questions

Hi Frank,
You kindly replied to us about various settings we wanted to try on a trials cruise. We are now on the ship and wondered about the following....
Our question - Also, would it be possible to directly link the EM120 and EA600 without going through the SSU so that the EA600 could act in passive mode and get round the problem of the EM120 not being the master instrument.

Your reply - Yes it is possible by simply using trig output pulse from EM120 to trig the EA in passive mode!

What do we need to do to link the EM120 trig output pulse to the EA in passive mode. We would welcome a swift reply as we are only onboard for a couple of days.

Cheers
Alex

km.support@kongsberg.com wrote:

Hi Alex, in our mailbox your mail have been listed for a while informing that the mail have been replied to.....but unfortunate I can not find the answer. Therefore I put another answer to your questions and hope you still can use some input to your challenging sync problem. My direct answer to the different questions is put into your text below.

Please disregard this mail in case you have received an answer and solved the problem.

Please do not hesitate to contact us again in case the answer is unclear or insufficient.

Best regards
Frank Wilhelmsen
Service manager
Kongsberg Maritime
Subsea Division - Hydrographic products

Voice +47 3302 3984
Mobile +47 9920 3984

Kongsberg Maritime Subsea
Strandpromenaden 50
N-3190 Horten
Norway

'Please note, this message is intended only for the use of the individuals to whom it is addressed and contains information that is privileged, confidential and exempt from disclosure under applicable law'
Inactive hide details for "Alexander Tate"
<AJTATE@bas.ac.uk>"Alexander Tate" AJTATE@bas.ac.uk

"Alexander Tate" <AJTATE@bas.ac.uk>
22.07.2008 11:01

To km.hydrographic.support@kongsberg.com

cc

Subject
>
> Re: Several SSU related questions
>
> Hi Torgrim,
> Thanks for the reply. What we are after is definitely not a normal setup as we have competing scientific needs and we're looking for a compromise setup that will satisfy everyone.
>
> If the instruments (EM120, EK60 and ADCP) were to be triggered simultaneously from the SSU (ADCP as master) in deep water, would the EM120 ignore subsequent triggers whilst it was transmitting and receiving its signal?
> Yes, the EM120 will ignore all attempt of trigging a new pulse before it has finished and ready for next ping!
>
> Also, would it be possible to directly link the EM120 and EA600 without going through the SSU so that the EA600 could act in passive mode and get round the problem of the EM120 not being the master instrument.
> Yes it is possible by simply using trig output pulse from EM120 to trig the EA in passive mode!
>
> I am aware that what we are trying to do may well cause interference amongst the instruments as they are no longer operated synchronously. We will look at any interference on our trials cruise. For now, I'm just trying to find out if what we want to do is technically possible.
>
> Also, if this isn't a good solution, how do other operators get round the problem of acquiring good ADCP and EK60 data while also getting multibeam depths in deep water?

> Good question....the problem with acoustic signals is that they may interfere with each other and the SSU will group them appart so that this not happens. The trade off for sync and group instruments is that the ping rate will be reduced. In case that the max ping rate must be obtained and all instruments must be in use there is in fact no good working solution and you have to test and see the effect (checking data quality) when using different instruments in various configurations.
>
> Cheers
> Alex
>
> >>> km.support@kongsberg.com 08/07/08 12:23 >>>
>
> Hi
>
> First of all the ADPC is very difficult to synchronize and work properly.
>
> 1. A "normal" setup the EM120 is master, the reason for this is that the EM120 needs up to 200ms
> from trigg signal is received until it is actually transmitting (pitch and yawstab. calculations).
> The trigg out from EM120 is then going back to the SSU which is trigging the other equipment. That means if EM120 is set as master the SSU will not trigger the rest of the equipment if the EM120 was not ready. And if EM120 is not set to master the you do not have full control of the EM120 transmitter, if EM120 is not set as master the EA600 cannot use the EM120 centre beam.
>
> 3.A thought we have had but never tested (again the EM120/EA600 is the problem). If the ADCP is set as master but the ADPC itself is not set to external trigg would mean that it is operating by itself and giving trigg in pulses. If it is also set to fixed time that is larger than the interval between watercolomn and bottom tracking the SSU should only recognise the first trigg puls. The as described above the EM120 might cause problems because you do not have full control of the transmitter if it is not set as master.
>
> I hope this help or clarified things.
>

> Best Regards
>
> Torgrim Eldevik
>
>
> "Alexander Tate"
>
> <AJTATE@bas.ac.uk>
>
To
> 01.07.2008 16:22
> km.support.aberdeen@kongsberg.com
>
Subject Several SSU related questions

>
> Hi,
> I work for the British Antarctic Survey and we have a suite of your instruments aboard the RRS James Clark Ross. The ship performs many types of scientific cruises and we would like to run our different echo sounders together as efficiently as possible. Whilst we had effective' SSU configurations to deal with this in the past, a new ADCP fitted to the vessel has meant we need to re-address the issue and we plan to have a short trials cruise in October. In preparation for this we have a few questions for you to hopefully answer.
>
> 1) We wish to run the ADCP (an RDI 75 kHz surveyor), EK60, EM120 and EA600 through the SSU so that they all ping at the same time. We wish to do this at a fast ping rate (approx 3 seconds), whatever the water depth, such that the EM120 is triggered only when it has finished collecting data from its last ping. Hence in deep water the SSU will make sure the EK60 and the ADCP are getting decent data coverage while the EM120 will ignore triggers until it has finished listening for a return. Will the EM120 work in this way?
>
> 2) In most water depths the EA600 is operated in passive mode and listens for the EM120 centre beam return. Would this still work in the scenario outlined above?
>
> 3) When in shallow water (<1000m), in order to calibrate, we must use the ADCP in bottom tracking mode. In this mode it pings twice per single ensemble (one ping for the water column and the second to look at near bottom). These pings must be controlled by the ADCP (unless you know of a way in which the SSU handles this). We wish the master instrument of the SSU to be the ADCP such that for each ping required by the ADCP (the water column one and then the near bottom one) a new trigger is given to all the instruments. Is this possible? Whilst it would result in a variable ping rate, it would enable all instruments to ping synchronously.
>
> Cheers
> Alex
>
> ps I'm happy to provide more detail or clarify the questions if necessary.

Appendix 9

ADCP Matlab processing changes JR218

During the trials cruise aimed at organising the simultaneous use of different acoustic instruments glitches were noted in the navigation data in the N1R files. These resulted in spikes in the final velocities and therefore removing them was attempted. The glitches meant ship speed became unrealistically variable and heading deviated from the true heading. The ship was not pitching or rolling significantly during the periods (which could cause variation in ship speed at 2 or 4 second intervals). On further investigation the glitches seem to occur at quarter past the hour, but it is not known why!

To remove the glitches a running median and standard deviation was found for ship heading and speed and pings more than 3 standard deviations away from the median noted, also pings with ship acceleration greater than 1 m/s^2 were noted. If points fulfilled these criteria for heading and one of ship speed or acceleration or just 6 standard deviations out in heading then they were removed, together with the 14 pings each side of them. This process was then run a second time to catch pings remaining after the first clean (the standard deviations being much smaller second time around after the worst pings are removed). The number of pings removed is printed to the screen and is generally less than 1000 in total (out of 15-20000 pings).

The final part of the new script then uses the cleaned ship speed and running standard deviations to clean bottom track velocities, which show spikes in them, by removing any bottom track velocities greater than 3 standard deviations different from ship velocity. This needs to be disabled if the given transducer alignment offset is different from the actual one by order degrees (rather than order 0.1 degres).

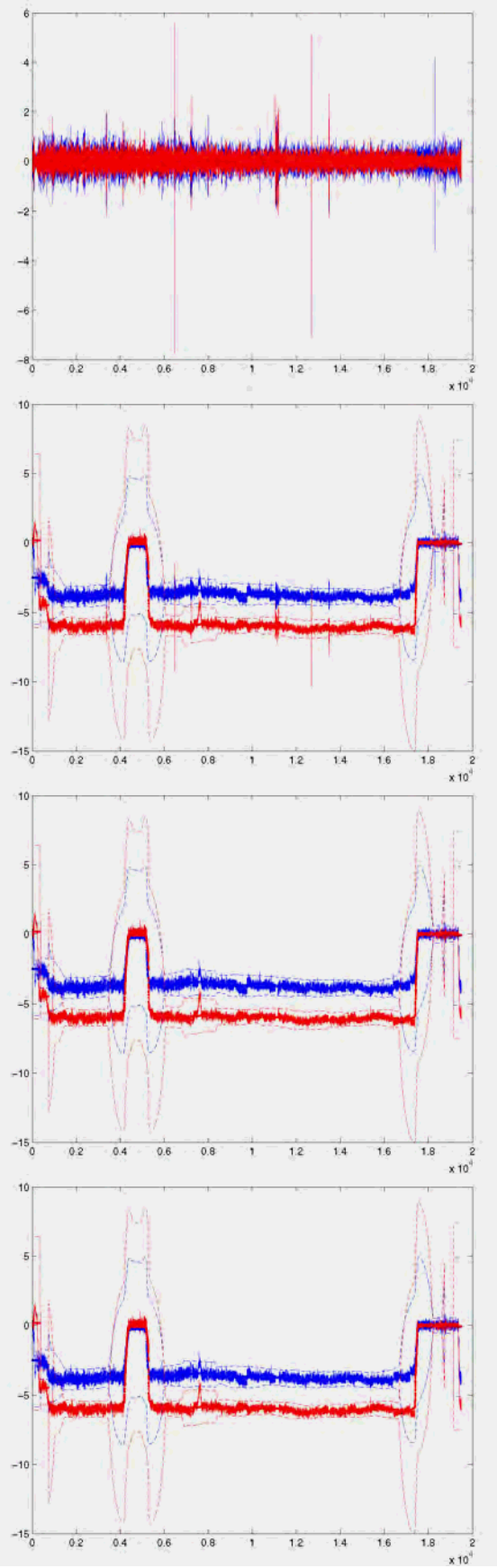
The new script is vel_clean_plus_ship.m – it is not fast, but it works; if quick-and-dirty plots are wanted it can be disabled by just commenting it out.

Associated changes to other scripts are to ship_vel.m where the ship speed is not set to bottom track, to allow it to be cleaned and to then be used to clean the bottom track velocities. Average_pings.m has also been changed to put in a minimum threshold (currently 10) for the number of good pings needed to make a 2 minute ensemble, else velocities for the 2 minute period are set to NaNs. This was due to data still looking bad after the navigation spike removal, due to averaging over a very small number of pings.

Figures

Next page: Ship acceleration and the result of the cleaning process on ship velocity and heading

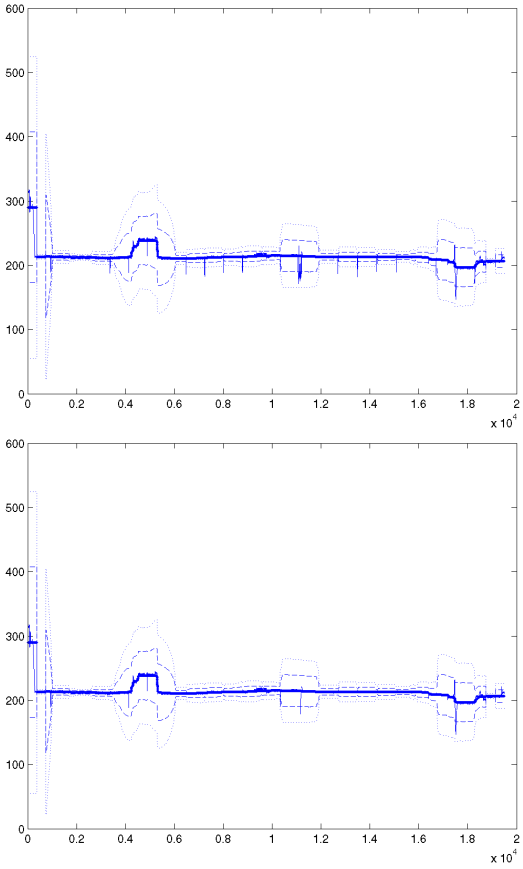
Next but one page: Output from a days ADCP data before and after cleaning, note the bad data falls at quarter past the hour, but not every hour. This may aid future processing or identification of the source of the problems, though nothing was immediately obvious on the ship.

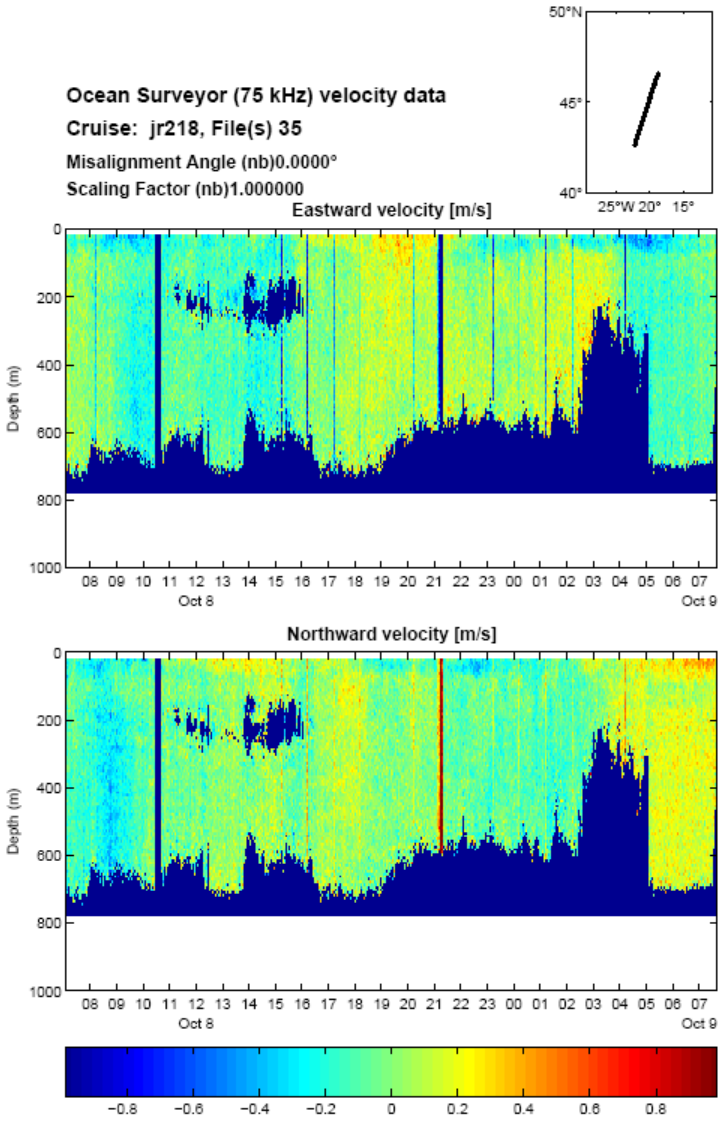


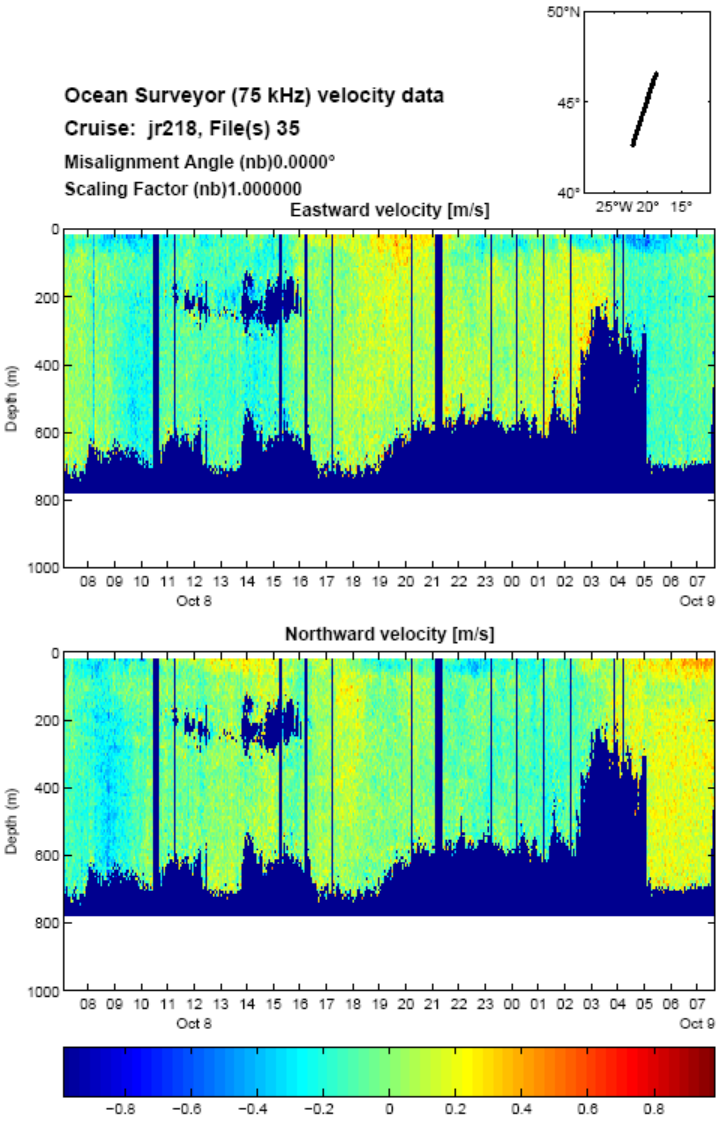
Top left: initial ship acceleration

Below left: Ship velocity initially, after one loop of cleaning and final.

Below right: Ship heading initially, after one loop of cleaning and final. The dashed lines represent 3 standard deviations each side of a running median, dotted line for heading is 6 standard deviations.




Ocean Surveyor (75 kHz) velocity data
Cruise: jr218, File(s) 35
Misalignment Angle (nb)0.0000°
Scaling Factor (nb)1.000000
50°N
45°
40°
25°W 20° 15°
Eastward velocity [m/s]
Depth (m)
0
200
400
600
800
1000
08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07
Oct 8
Oct 9
Northward velocity [m/s]
−0.8 −0.6 −0.4 −0.2 0 0.2 0.4 0.6 0.8


Ocean Surveyor (75 kHz) velocity data
Cruise: jr218, File(s) 35
Misalignment Angle (nb)0.0000°
Scaling Factor (nb)1.000000
50°N
45°
40°
25°W 20° 15°
Eastward velocity [m/s]
Depth (m)
0
200
400
600
800
1000
08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07
Oct 8
Oct 9
Northward velocity [m/s]
−0.8 −0.6 −0.4 −0.2 0 0.2 0.4 0.6 0.8

Appendix 1:

JCR BRIDGE LOG, JR218, AMT-18

Sort code	Time	Event	Lat	Lon	Comment	User
1304	10/03/2008 09:00	1	53.62682	-0.18887	Sail Immingham UK	bridge
1303	10/04/2008 12:58	CTD 001	50.4086	-1.50016	On station for CTD Test	bridge
1302	10/04/2008 13:30	CTD 001	50.40293	-1.5067	Off Station	bridge
1301	10/06/2008 04:25	Station 02	49.48207	-9.83783	Off Passage	bridge
1300	10/06/2008 04:33	CTD 002	49.48239	-9.84743	Vessel Set Up In D.P.	bridge
1299	10/06/2008 04:34	CTD 002	49.48238	-9.84743	Mid-ships Gantry unlashed	bridge
1298	10/06/2008 04:53	CTD 002	49.48238	-9.84745	CTD Ready. Off Deck	bridge
1297	10/06/2008 04:56	CTD 002	49.48239	-9.84747	CTD Deployed	bridge
1296	10/06/2008 05:07	CTD 002	49.4824	-9.84746	CTD at 134m Commencing recovery	bridge
1295	10/06/2008 05:32	CTD 002	49.48241	-9.84744	CTD at the surface	bridge
1294	10/06/2008 05:34	CTD 002	49.48241	-9.84744	CTD on deck	bridge
1293	10/06/2008 05:54		49.48241	-9.84745	Bongo Net deployment cancelled	bridge
1292	10/06/2008 06:15	CTD 003	49.48239	-9.84748	CTD off the deck	bridge
1291	10/06/2008 06:18	CTD 003	49.48238	-9.84747	CTD deployed	bridge
1290	10/06/2008 06:25	CTD 003	49.48269	-9.84721	CTD at 134m - Commencing recovery	bridge
1289	10/06/2008 06:48	CTD 003	49.48435	-9.84573	CTD at the surface	bridge
1288	10/06/2008 06:51	CTD 003	49.48438	-9.84567	CTD on deck	bridge
1287	10/06/2008 06:57		49.48438	-9.84568	Mid-ships gantry secured	bridge
1286	10/06/2008 07:05		49.48436	-9.84568	MVP deployment cancelled. Vessel off DP and proceeding to next station.	bridge
1285	10/06/2008 07:10	Station 02	49.48171	-9.86077	Resumed Passage	bridge
1284	10/06/2008 12:42	Station 3	49.3718	-11.4814	On station end of passage	bridge
1283	10/06/2008 13:10	CTD 004	49.36463	-11.5189	CTD Deployed	bridge
1282	10/06/2008 13:20	OPT 001	49.36441	-11.519	Optics Rig Deployed	bridge
1281	10/06/2008 13:23	CTD 004	49.36455	-11.5184	CTD @ 500m	bridge
1280	10/06/2008 13:42	OPT 001	49.35269	-11.6926	Optics Rig Recovered	bridge
1279	10/06/2008 13:57	CTD 004	49.3648	-11.5157	CTD Recovered	bridge
1278	10/06/2008 14:10	CTD 004	49.3524	-11.6993	Off Station Resume Passage	bridge
1277	10/07/2008 03:42		49.14919	-14.5478	Check weather for CTD 005	bridge
1276	10/07/2008 03:50		49.15327	-14.5695	Resume passage	bridge
1275	10/07/2008 04:05	Station 04	49.14933	-14.6327	Off Passage	bridge
1274	10/07/2008 04:15		49.14909	-14.6525	Vessel on Station in DP	bridge
1273	10/07/2008 04:17		49.14926	-14.6523	Mid-ships Gantry unlashed	bridge
1272	10/07/2008 04:27	CTD 005	49.14925	-14.6524	CTD deployed	bridge
1271	10/07/2008 04:33	CTD 005	49.14924	-14.6524	CTD Ready. Off Deck	bridge
1270	10/07/2008 04:35	Net 001	49.14926	-14.6524	Bongo nets off the deck	bridge
1269	10/07/2008 04:37	Net 001	49.14925	-14.6524	Bongo nets deployed from starboard fore deck.	bridge
1268	10/07/2008 04:38	CTD 005	49.14925	-14.6524	CTD at 300m. Commenced recovery	bridge
1267	10/07/2008 04:43	Net 001	49.14925	-14.6524	Bongo nets at 175m. Commenced recovery	bridge
1266	10/07/2008 04:52	Net 001	49.14926	-14.6524	Bongo nets at the surface	bridge
1265	10/07/2008 04:53	Net 001	49.14923	-14.6524	Bongo nets on deck	bridge
1264	10/07/2008 05:00	Net 001	49.14922	-14.6524	Science crane secured	bridge
1263	10/07/2008 05:08	CTD 005	49.14927	-14.6524	CTD at the surface	bridge
1262	10/07/2008 05:11	CTD 005	49.14928	-14.6524	CTD on deck	bridge
1261	10/07/2008 05:57	CTD 006	49.14929	-14.6524	CTD off the deck	bridge
1260	10/07/2008 05:59	CTD 006	49.14926	-14.6524	CTD deployed	bridge
1259	10/07/2008 06:14	CTD 006	49.14928	-14.6524	CTD at 500m. Commenced recovery	bridge
1258	10/07/2008 06:14	CTD 006	49.14928	-14.6524	CTD at 500m. Commenced recovery	bridge
1257	10/07/2008 06:42	CTD 006	49.14928	-14.6524	CTD at the surface	bridge
1256	10/07/2008 06:45	CTD 006	49.14931	-14.6524	CTD on deck	bridge
1255	10/07/2008 06:52	Station 04	49.14931	-14.6524	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
1254	10/07/2008 06:58	Station 04	49.14829	-14.6645	Resumed Passage	bridge
1253	10/07/2008 12:19	Station 05	48.8804	-16.1689	Decrease Power for coming on Station	bridge
1252	10/07/2008 12:20	CTD 007	48.87948	-16.1736	On Station - in DP	bridge
1251	10/07/2008 12:34	CTD 007	48.86022	-16.1929	Gantry unlashed	bridge

1250	10/07/2008 12:47	CTD 007	48.8602	-16.1929	CTD on deck	bridge
1249	10/07/2008 12:49	CTD 007	48.87173	-16.1959	CTD in the water. Deploying to 500m	bridge
1248	10/07/2008 13:02	OPT 002	48.86017	-16.1929	Optics Rig Deployed	bridge
1247	10/07/2008 13:14	CTD 007	48.86612	-16.1936	CTD @ 500m	bridge
1246	10/07/2008 13:35	OPT 002	48.86015	-16.1929	Optics Rig Recovered	bridge
1245	10/07/2008 13:45	CTD 007	48.86013	-16.1929	CTD Recovered on deck - Gantry stowed	bridge
1244	10/07/2008 14:07	CTD 007	48.86014	-16.1929	CTD out of the water	bridge
1243	10/07/2008 14:20	CTD 007	48.86113	-16.202	Off Station Resume Passage	bridge
1242	10/08/2008 04:05	Station 06	46.59021	-18.6875	Off Passage	bridge
1241	10/08/2008 04:12	Station 06	46.59064	-18.6966	Vessel Set Up In D.P.	bridge
1240	10/08/2008 04:16	Station 06	46.59067	-18.6965	Mid-ships Gantry unlashed	bridge
1239	10/08/2008 04:27	CTD 008	46.59066	-18.6966	CTD off the deck	bridge
1238	10/08/2008 04:29	CTD 008	46.59065	-18.6965	CTD deployed	bridge
1237	10/08/2008 04:35	Net 002	46.59063	-18.6965	Bongo nets off the deck	bridge
1236	10/08/2008 04:36	Net 002	46.59065	-18.6965	Bongo nets deployed from starboard fore deck.	bridge
1235	10/08/2008 04:41	CTD 008	46.59065	-18.6966	CTD at 300m. Commenced recovery	bridge
1234	10/08/2008 04:42	Net 002	46.59065	-18.6966	Bongo Nets at 175m. Commenced recovery	bridge
1233	10/08/2008 04:51	Net 002	46.59065	-18.6966	Bongo nets at the surface	bridge
1232	10/08/2008 04:52	Net 002	46.59065	-18.6965	Bongo nets on deck	bridge
1231	10/08/2008 04:58	Net 002	46.59065	-18.6965	Science crane secured	bridge
1230	10/08/2008 05:10	CTD 008	46.5906	-18.6965	CTD at the surface	bridge
1229	10/08/2008 05:12	CTD 008	46.59059	-18.6965	CTD on deck	bridge
1228	10/08/2008 05:52	CTD 009	46.59065	-18.6965	CTD off the deck	bridge
1227	10/08/2008 05:54	CTD 009	46.59068	-18.6966	CTD deployed	bridge
1226	10/08/2008 06:09	CTD 009	46.59068	-18.6966	CTD at depth 500m. Commenced recovery	bridge
1225	10/08/2008 06:41	CTD 009	46.59068	-18.6966	CTD at the surface	bridge
1224	10/08/2008 06:45	CTD 009	46.59067	-18.6966	CTD on deck	bridge
1223	10/08/2008 06:53	Station 06	46.59067	-18.6966	Mid-ships gantry secured. Preparing for MVP deployment	bridge
1222	10/08/2008 07:09	Station 06	46.59065	-18.6966	Vessel off D.P. for MVP deployment	bridge
1221	10/08/2008 07:11	MVP 01	46.59106	-18.6972	MVP deployed. Adjusting ships speed as requested	bridge
1220	10/08/2008 07:30	Station 06	46.58533	-18.7357	Resume passage	bridge
1219	10/08/2008 07:50	Station 06	46.53839	-18.7779	Vessel's speed 11.5knots	bridge
1218	10/08/2008 08:30	MVP 01	46.41394	-18.8929	Deployed; 6m depth - 130m cable length	bridge
1217	10/08/2008 12:16	MVP 01	45.68368	-19.5631	Begin Hauling MVP - Reduce Power for coming on Station	bridge
1216	10/08/2008 12:30	Station 07	45.66361	-19.5857	On station - in DP for CTD 010	bridge
1215	10/08/2008 12:30	MVP 01	45.66361	-19.5857	MVP on Deck	bridge
1214	10/08/2008 12:35	CTD 010	45.66351	-19.5863	CTD Cleared away and on deck	bridge
1213	10/08/2008 12:44	CTD 010	45.6635	-19.5863	CTD in the water. Deploying to 300m	bridge
1212	10/08/2008 12:45	OPT 003	45.66357	-19.5863	Optics Rig Deployed	bridge
1211	10/08/2008 12:54	OPT 003	45.66421	-19.5869	Optics Rig @ 180m and recovering	bridge
1210	10/08/2008 13:09	OPT 003	45.66513	-19.5876	Optics Rig Recovered	bridge
1209	10/08/2008 13:23	CTD 010	45.66613	-19.5885	CTD out of the water	bridge
1208	10/08/2008 13:25	CTD 010	45.66619	-19.5885	CTD on deck.	bridge
1207	10/08/2008 13:32	Station 07	45.66677	-19.589	All secure on deck	bridge
1206	10/08/2008 13:38	Station 07	45.66735	-19.5897	Vessel moving off D.P	bridge
1205	10/08/2008 13:45	Station 07	45.66334	-19.6034	Off Station Resume Passage	bridge
1204	10/08/2008 16:36	XBT 01	45.11771	-20.0739	Off passage. Reducing speed to 10kts for XBT deployment	bridge
1203	10/08/2008 16:41	XBT 01	45.10434	-20.0853	XBT No.1 Deployed (ships speed 10kts)	bridge
1202	10/08/2008 16:45	XBT 01	45.09471	-20.0936	Increasing speed	bridge
1201	10/08/2008 16:50	XBT 01	45.08018	-20.1061	Resumed Passage	bridge
1200	10/09/2008 05:05	Station 08	42.68334	-22.1853	Off Passage	bridge
1199	10/09/2008 05:13	Station 08	42.67296	-22.1949	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
1198	10/09/2008 05:20	CTD 011	42.67303	-22.1949	CTD off the deck	bridge
1197	10/09/2008 05:23	CTD 011	42.67303	-22.1949	CTD deployed	bridge
1196	10/09/2008 05:29	Net 003	42.67303	-22.1949	Bongo nets off the deck	bridge
1195	10/09/2008 05:31	Net 003	42.67303	-22.1949	Bongo nets deployed	bridge

1194	10/09/2008 05:34	CTD 011	42.67303	-22.1949	CTD at 300m. Commenced recovery	bridge
1193	10/09/2008 05:37	Net 003	42.67305	-22.1949	Bongo Nets at 180m. Commenced recovery	bridge
1192	10/09/2008 05:44	Net 003	42.67303	-22.1949	Bongo net clear of the water.	bridge
1191	10/09/2008 05:46	Net 003	42.67303	-22.195	Bongo nets on deck	bridge
1190	10/09/2008 06:00	CTD 011	42.67303	-22.1949	CTD at the surface	bridge
1189	10/09/2008 06:02	CTD 011	42.67304	-22.1949	CTD on deck	bridge
1188	10/09/2008 06:39	CTD 012	42.67301	-22.1949	CTD off the deck	bridge
1187	10/09/2008 06:41	CTD 012	42.67303	-22.1949	CTD Deployed	bridge
1186	10/09/2008 06:55	CTD 012	42.67304	-22.195	CTD at 500m. Commenced recovery	bridge
1185	10/09/2008 07:21	CTD 012	42.67301	-22.1949	CTD at the surface	bridge
1184	10/09/2008 07:23	CTD 012	42.67302	-22.1949	CTD off the deck	bridge
1183	10/09/2008 07:31	Station 08	42.67302	-22.1949	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
1182	10/09/2008 07:36	Station 08	42.6645	-22.2029	Resume Passage	bridge
1181	10/09/2008 17:25	XBT 02	40.74355	-23.7878	Off Passage. Reducing speed to 10kts	bridge
1180	10/09/2008 17:29	XBT 02	40.73338	-23.7967	XBT deployed (ship's speed 10kts)	bridge
1179	10/09/2008 17:32	XBT 02	40.72587	-23.8031	Increasing to passage speed	bridge
1178	10/09/2008 17:35	XBT 02	40.71703	-23.8107	Resumed passage	bridge
1177	10/10/2008 05:05	Station 09	38.89243	-25.3151	Off Passage	bridge
1176	10/10/2008 05:14	Station 09	38.88195	-25.3242	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
1175	10/10/2008 05:18	CTD 013	38.88198	-25.3242	CTD off the deck	bridge
1174	10/10/2008 05:20	CTD 013	38.88199	-25.3243	CTD deployed	bridge
1173	10/10/2008 05:28	Net 004	38.88197	-25.3243	Bongo nets off the deck	bridge
1172	10/10/2008 05:30	Net 004	38.88198	-25.3242	Bongo nets deployed.	bridge
1171	10/10/2008 05:31	CTD 013	38.88199	-25.3243	CTD at 300m. Commenced recovery	bridge
1170	10/10/2008 05:36	Net 004	38.88198	-25.3243	Bongo nets at 180m. Commenced recovery	bridge
1169	10/10/2008 05:44	Net 004	38.88198	-25.3243	Bongo nets at the surface	bridge
1168	10/10/2008 05:46	Net 004	38.88198	-25.3243	Bongo nets on deck	bridge
1167	10/10/2008 05:58	CTD 013	38.88198	-25.3243	CTD at the surface	bridge
1166	10/10/2008 06:00	CTD 013	38.88199	-25.3243	CTD on deck	bridge
1165	10/10/2008 06:48	CTD 014	38.88199	-25.3243	CTD off the deck	bridge
1164	10/10/2008 06:50	CTD 014	38.88196	-25.3243	CTD deployed	bridge
1163	10/10/2008 07:04	CTD 014	38.88196	-25.3243	CTD at 500m. Commenced recovery	bridge
1162	10/10/2008 07:30	CTD 014	38.88198	-25.3243	CTD at the surface	bridge
1161	10/10/2008 07:32	CTD 014	38.88198	-25.3243	CTD on deck	bridge
1160	10/10/2008 07:40	Station 09	38.88197	-25.3243	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
1159	10/10/2008 07:45	Station 09	38.8771	-25.3279	Resume Passage	bridge
1158	10/11/2008 05:05	Station 10	36.01559	-27.722	Off Passage	bridge
1157	10/11/2008 05:15	Station 10	36.01163	-27.7373	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
1156	10/11/2008 05:26	CTD 015	36.01167	-27.7373	CTD deployed	bridge
1155	10/11/2008 05:28	CTD 015	36.01167	-27.7373	CTD off the deck	bridge
1154	10/11/2008 05:31	Net 005	36.01166	-27.7373	Bongo nets off the deck	bridge
1153	10/11/2008 05:33	Net 005	36.01167	-27.7373	Bongo nets deployed.	bridge
1152	10/11/2008 05:36	Net 005	36.01168	-27.7373	Problem with snatch block on crane. Recovering nets.	bridge
1151	10/11/2008 05:38	CTD 015	36.01168	-27.7373	CTD at 300m. Commenced recovery	bridge
1150	10/11/2008 05:39	Net 005	36.01167	-27.7373	Bongo nets at the surface	bridge
1149	10/11/2008 05:40	Net 005	36.01168	-27.7373	Bongo nets on deck	bridge
1148	10/11/2008 05:44	Net 006	36.01168	-27.7373	Snatch block on crane fixed. Bongo nets off the deck for deployment	bridge
1147	10/11/2008 05:45	Net 006	36.01168	-27.7373	Bongo nets deployed	bridge
1146	10/11/2008 05:51	Net 006	36.01167	-27.7373	Bongo nets at 180m. Commenced recovery	bridge
1145	10/11/2008 05:59	Net 006	36.01168	-27.7373	Bongo nets at the surface	bridge
1144	10/11/2008 06:00	Net 006	36.01168	-27.7373	Bongo nets on deck	bridge
1143	10/11/2008 06:05	CTD 015	36.01166	-27.7373	CTD at the surface	bridge
1142	10/11/2008 06:07	CTD 015	36.01166	-27.7373	CTD on deck	bridge
1141	10/11/2008 06:51	CTD 016	36.01167	-27.7373	CTD off the deck	bridge
1140	10/11/2008 06:53	CTD 016	36.01167	-27.7373	CTD deployed	bridge

1139	10/11/2008 07:06	CTD 016	36.01167	-27.7373	CTD at 500m. Commenced recovery	bridge
1138	10/11/2008 07:33	CTD 016	36.01165	-27.7373	CTD at the surface	bridge
1137	10/11/2008 07:35	CTD 016	36.01166	-27.7373	CTD on deck	bridge
1136	10/11/2008 07:43	Station 10	36.01167	-27.7373	Mid-ships gantry secured. Vessel out of DP and proceeding at 1kt for MVP deployment	bridge
1135	10/11/2008 07:53	MVP 002	36.0098	-27.7405	MVP deployed (ships speed 1kt)	bridge
1134	10/11/2008 07:56	MVP 002	36.00904	-27.7415	Increasing ship speed to 5kts	bridge
1133	10/11/2008 07:59	MVP 002	36.00695	-27.7439	Increasing ship speed to 8kts	bridge
1132	10/11/2008 08:02	MVP 002	36.00228	-27.7491	Increasing ship spped to 11.5kts (Passage Speed)	bridge
1131	10/11/2008 08:05	Station 10	35.99587	-27.756	Resumed passage	bridge
1130	10/11/2008 08:10	MVP 002	35.98407	-27.7689	Requested to reduce ships spped to 11.5kts WT (=10.4kts GT)	bridge
1129	10/11/2008 13:15	MVP 002	35.32958	-28.4646	Slow to 1knot for recovery of MVP	bridge
1128	10/11/2008 13:26	MVP 002	35.31676	-28.4702	MVP out of the water	bridge
1127	10/11/2008 13:30	Station 11	35.31533	-28.4703	On station for CTD 17	bridge
1126	10/11/2008 13:31	MVP 002	35.3151	-28.4703	MVP secured on deck	bridge
1125	10/11/2008 13:33	Station 11	35.31486	-28.47	Gantry unlashed	bridge
1124	10/11/2008 13:38	Station 11	35.31462	-28.4691	CTD out on deck	bridge
1123	10/11/2008 13:43	CTD 017	35.31436	-28.4681	CTD in water and being deployed to 500m	bridge
1122	10/11/2008 13:44	OPT 004	35.31431	-28.468	Optics Rig Deployed	bridge
1121	10/11/2008 13:48	Net 007	35.31409	-28.4673	FWD net deployed	bridge
1120	10/11/2008 13:51	OPT004	35.31396	-28.4668	Optics Rig @ 180m and recovering	bridge
1119	10/11/2008 13:55	CTD 017	35.31383	-28.4663	CTD at 500m. Commenced recovery	bridge
1118	10/11/2008 14:01	Net 007	35.31377	-28.4662	FWD net recovered	bridge
1117	10/11/2008 14:09	Net 008	35.31357	-28.4655	FWD net deployed	bridge
1116	10/11/2008 14:15	Net 008	35.31331	-28.4646	FWD net recovered	bridge
1115	10/11/2008 14:16	OPT 004	35.31326	-28.4645	Optics Rig Recovered	bridge
1114	10/11/2008 14:22	CTD 017	35.31307	-28.4638	CTD out of the water	bridge
1113	10/11/2008 14:26	CTD 017	35.31295	-28.4634	CTD on deck	bridge
1112	10/11/2008 14:28	CTD 017	35.31289	-28.4632	Gantry and block secure.	bridge
1111	10/11/2008 14:47	Station 11	35.29541	-28.4796	Vessel @11.5 knots - off Station resumed passage	bridge
1110	10/12/2008 05:05	Station 12	33.30758	-30.7864	Off Passage	bridge
1109	10/12/2008 05:14	Station 12	33.29798	-30.7968	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
1108	10/12/2008 05:22	CTD 018	33.29785	-30.7969	CTD off the deck	bridge
1107	10/12/2008 05:24	CTD 018	33.29786	-30.7968	CTD deployed	bridge
1106	10/12/2008 05:30	Net 009	33.29789	-30.7968	Bongo nets off the deck	bridge
1105	10/12/2008 05:33	Net 009	33.29788	-30.7968	Bongo nets deployed	bridge
1104	10/12/2008 05:35	CTD 018	33.29787	-30.7968	CTD at 300m. Commenced recovery	bridge
1103	10/12/2008 05:39	Net 009	33.29787	-30.7968	Bongo nets at 180m. Commenced recovery	bridge
1102	10/12/2008 05:47	Net 009	33.29786	-30.7968	Bongo nets on deck	bridge
1101	10/12/2008 05:49	Net 009	33.29786	-30.7968	Bongo nets at the surface	bridge
1100	10/12/2008 06:00	CTD 018	33.29787	-30.7968	CTD at the surface	bridge
1099	10/12/2008 06:02	CTD 018	33.29787	-30.7968	CTD on deck	bridge
1098	10/12/2008 06:04	Net 010	33.29786	-30.7968	Bongo nets off the deck	bridge
1097	10/12/2008 06:06	Net 010	33.29786	-30.7968	Bongo nets deployed	bridge
1096	10/12/2008 06:12	Net 010	33.29786	-30.7968	Bongo nets at 180m. Commenced recovery	bridge
1095	10/12/2008 06:21	Net 010	33.29786	-30.7968	Bongo nets at the surface	bridge
1094	10/12/2008 06:23	Net 010	33.29786	-30.7968	Bongo nets on deck	bridge
1093	10/12/2008 06:43	CTD 019	33.29789	-30.7968	CTD off the deck	bridge
1092	10/12/2008 06:45	CTD 019	33.29788	-30.7968	CTD deployed	bridge
1091	10/12/2008 06:58	CTD 019	33.29787	-30.7968	CTD at 500m. Commenced recovery	bridge
1090	10/12/2008 07:23	CTD 019	33.29786	-30.7969	CTD at the surface	bridge
1089	10/12/2008 07:26	CTD 019	33.29786	-30.7969	CTD on deck	bridge
1088	10/12/2008 07:33	Station 12	33.29787	-30.7969	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
1087	10/12/2008 07:40	Station 12	33.2902	-30.8063	Resumed passage	bridge
1086	10/12/2008 13:18	Station 13	32.49986	-31.6972	Start slowing down for station – vessel off passage	bridge
1085	10/12/2008 13:26	CTD 020	32.49016	-31.7099	CTD on deck	bridge
1084	10/12/2008 13:29	Station 13	32.49005	-31.7102	On station for CTD 19	bridge

1083	10/12/2008 13:30	Station 13	32.49005	-31.7103	Gantry unlashed	bridge
1082	10/12/2008 13:36	Station 13	32.49003	-31.7102	Gantry stowed and secured	bridge
1081	10/12/2008 13:43	CTD 20	32.49007	-31.7102	CTD Deployed	bridge
1080	10/12/2008 13:44	OPT 005	32.49006	-31.7102	Optics Rig Deployed	bridge
1079	10/12/2008 13:47	Net 011	32.49004	-31.7102	FWD net deployed	bridge
1078	10/12/2008 13:53	Net 011	32.49005	-31.7102	FWD net recovered	bridge
1077	10/12/2008 13:57	CTD 20	32.49003	-31.7102	CTD @ 500m and recovering	bridge
1076	10/12/2008 13:58	Net 012	32.49002	-31.7102	FWD net deployed	bridge
1075	10/12/2008 14:11	Net 012	32.49	-31.7102	FWD net recovered	bridge
1074	10/12/2008 14:19	OPT 005	32.48999	-31.7102	Optics Rig Recovered	bridge
1073	10/12/2008 14:24	CTD 020	32.49123	-31.7083	CTD out of the water	bridge
1072	10/12/2008 14:44	Station 13	32.47341	-31.7227	Vessel @11.5 knots - off Station resumed passage	bridge
1071	05:05:00 13/10/2008	Station 14	30.4836	-33.9409	Off Passage	bridge
1070	05:15:00 13/10/2008	Station 14	30.47242	-33.9513	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
1069	05:19:00 13/10/2008	CTD 021	30.47237	-33.9513	CTD off the deck	bridge
1068	05:22:00 13/10/2008	CTD 021	30.47237	-33.9513	CTD deployed	bridge
1067	05:28:00 13/10/2008	Net 013	30.47236	-33.9513	Bongo nets off the deck	bridge
1066	05:30:00 13/10/2008	Net 013	30.47238	-33.9513	Bongo nets deployed	bridge
1065	05:33:00 13/10/2008	CTD 021	30.47237	-33.9513	CTD at 300m. Commenced recovery	bridge
1064	05:35:00 13/10/2008	Net 013	30.47237	-33.9513	Bongo nets at 180m. Commenced recovery	bridge
1063	05:43:00 13/10/2008	Net 013	30.47236	-33.9512	Bongo nets at the surface	bridge
1062	05:45:00 13/10/2008	Net 013	30.47236	-33.9512	Bongo nets on deck	bridge
1061	06:01:00 13/10/2008	CTD 021	30.47237	-33.9512	CTD at the surface	bridge
1060	06:03:00 13/10/2008	CTD 021	30.47238	-33.9512	CTD on deck	bridge
1059	06:43:00 13/10/2008	CTD 022	30.47238	-33.9513	CTD off the deck	bridge
1058	06:45:00 13/10/2008	CTD 022	30.47236	-33.9512	CTD deployed	bridge
1057	06:47:00 13/10/2008	Net 014	30.47239	-33.9512	Bongo nets off the deck	bridge
1056	06:48:00 13/10/2008	Net 014	30.47239	-33.9512	Bongo nets deployed	bridge
1055	06:54:00 13/10/2008	Net 014	30.47239	-33.9513	Bongo nets at 180m. Commenced recovery	bridge
1054	07:00:00 13/10/2008	CTD 022	30.47236	-33.9513	CTD at 500m. Commenced recovery	bridge
1053	07:02:00 13/10/2008	Net 014	30.47237	-33.9513	Bongo nets at the surface	bridge
1052	07:04:00 13/10/2008	Net 014	30.47237	-33.9513	Bongo nets on deck	bridge
1051	07:22:00 13/10/2008	CTD 022	30.47236	-33.9513	CTD at the surface	bridge
1050	07:25:00 13/10/2008	CTD 022	30.47235	-33.9513	CTD on deck	bridge
1049	07:31:00 13/10/2008	Station 14	30.47237	-33.9513	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
1048	07:39:00 13/10/2008	Station 14	30.46257	-33.9615	Resumed passage	bridge
1047	13:16:00 13/10/2008	Station 15	29.67803	-34.828	Reduce speed for Station 15	bridge
1046	13:24:00 13/10/2008	Station 15	29.66968	-34.8336	On station for CTD 22.	bridge
1045	13:26:00 13/10/2008	Station 15	29.66969	-34.8335	Gantry unlashed	bridge
1044	13:32:00 13/10/2008	CTD 023	29.66968	-34.8335	CTD deployed	bridge
1043	13:33:00 13/10/2008	Net 015	29.66968	-34.8335	Net deployed FWD	bridge
1042	13:36:00 13/10/2008	OPT 006	29.66968	-34.8335	Optics Rig Deployed	bridge
1041	13:39:00 13/10/2008	Net 015	29.66968	-34.8335	FWD net recovered	bridge
1040	13:43:00 13/10/2008	Net 016	29.66968	-34.8335	Net deployed FWD	bridge
1039	13:46:00 13/10/2008	OPT 006	29.66967	-34.8335	Optics Rig @ 180m and recovering	bridge
1038	13:48:00 13/10/2008	CTD 023	29.66967	-34.8336	CTD @ 500m and recovering	bridge
1037	13:50:00 13/10/2008	Net 016	29.66967	-34.8336	FWD net recovered	bridge
1036	14:10:00 13/10/2008	OPT 006	29.66969	-34.8336	Optics Rig Recovered	bridge
1035	14:24:00 13/10/2008	CTD 023	29.6697	-34.8336	CTD out of the water	bridge
1034	14:26:00 13/10/2008	CTD 023	29.6697	-34.8336	CTD on deck	bridge
1033	14:30:00 13/10/2008	Station 15	29.66969	-34.8335	Gantry stowed and secured	bridge
1032	14:38:00 13/10/2008	Station 015	29.6697	-34.8336	Moving off station	bridge
1031	14:48:00 13/10/2008	Station 015	29.66156	-34.8468	Vessel @11.7 knots - off Station resumed passage	bridge
1030	05:05:00 14/10/2008	Station 016	27.64078	-37.0251	Off Passage	bridge
1029	05:13:00 14/10/2008	Station 016	27.63166	-37.0305	Vessel Set Up In D.P. Side Gantry unlashed	bridge
1028	05:21:00 14/10/2008	CTD 024	27.63164	-37.0305	CTD off the deck	bridge
1027	05:23:00 14/10/2008	CTD 024	27.63164	-37.0306	CTD deployed	bridge
1026	05:29:00 14/10/2008	Net 017	27.63164	-37.0306	Bongo nets off the deck	bridge
1025	05:30:00 14/10/2008	Net 017	27.63164	-37.0306	Bongo nets deployed	bridge
1024	05:33:00 14/10/2008	CTD 024	27.63164	-37.0305	CTD at 300m	bridge
1023	05:36:00 14/10/2008	Net 017	27.63164	-37.0305	Bongo nets at 180m. Commenced recovery	bridge

1022	05:43:00 14/10/2008	Net 017	27.63164	-37.0306	Bongo nets at the surface	bridge
1021	05:44:00 14/10/2008	Net 017	27.63165	-37.0306	Bongo nets on deck	bridge
1020	05:58:00 14/10/2008	CTD 022	27.63164	-37.0305	CTD at the surface	bridge
1019	06:00:00 14/10/2008	CTD 024	27.63165	-37.0305	CTD on deck	bridge
1018	06:38:00 14/10/2008	CTD 025	27.63165	-37.0305	CTD off the deck	bridge
1017	06:40:00 14/10/2008	CTD 025	27.63166	-37.0306	CTD deployed	bridge
1016	06:41:00 14/10/2008	Net 018	27.63166	-37.0305	Bongo nets off the deck	bridge
1015	06:42:00 14/10/2008	Net 018	27.63166	-37.0306	Bongo nets deployed	bridge
1014	06:48:00 14/10/2008	Net 018	27.63165	-37.0305	Bongo nets at 180m. Commenced recovery	bridge
1013	06:53:00 14/10/2008	CTD 025	27.63164	-37.0306	CTD at 500m. Commenced recovery	bridge
1012	06:55:00 14/10/2008	Net 018	27.63164	-37.0305	Bongo nets at the surface	bridge
1011	06:57:00 14/10/2008	Net 018	27.63165	-37.0306	Bongo nets on deck	bridge
1010	07:21:00 14/10/2008	CTD 025	27.63164	-37.0306	CTD at the surface	bridge
1009	07:23:00 14/10/2008	CTD 025	27.63163	-37.0305	CTD on deck	bridge
1008	07:30:00 14/10/2008	Station 016	27.63162	-37.0306	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
1007	07:37:00 14/10/2008	Station 016	27.62376	-37.0406	Resumed passage	bridge
1006	13:17:00 14/10/2008	Station 017	26.81968	-37.8965	Vessel off passage	bridge
1005	13:25:00 14/10/2008	Station 017	26.81205	-37.8961	Vessel on Station in DP	bridge
1004	13:25:00 14/10/2008	Station 017	26.81205	-37.8961	Gantry unlashed	bridge
1003	13:33:00 14/10/2008	CTD 026	26.81246	-37.8959	CTD Deployed	bridge
1002	13:35:00 14/10/2008	OPT 007	26.81251	-37.8959	Optics Rig Deployed	bridge
1001	13:44:00 14/10/2008	OPT 007	26.81305	-37.8956	Optics Rig @ 180m and recovering	bridge
1000	13:48:00 14/10/2008	CTD 026	26.81333	-37.8955	CTD @ 500m and recovering	bridge
999	14:09:00 14/10/2008	OPT 007	26.8142	-37.895	Optics Rig Recovered	bridge
998	14:22:00 14/10/2008	CTD 026	26.81417	-37.895	CTD Recovered on deck	bridge
997	14:27:00 14/10/2008	Station 017	26.81402	-37.8947	Gantry secure – vessel off station	bridge
996	14:41:00 14/10/2008	Station 017	26.79481	-37.9151	Vessel @11.7 knots – resumed passage	bridge
995	05:05:00 15/10/2008	Station 018	24.75395	-40.0803	Off Passage	bridge
994	05:15:00 15/10/2008	Station 018	24.74429	-40.0885	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
993	05:21:00 15/10/2008	CTD 027	24.74433	-40.0885	CTD off the deck	bridge
992	05:23:00 15/10/2008	CTD 027	24.74431	-40.0885	CTD deployed	bridge
991	05:35:00 15/10/2008	CTD 027	24.74432	-40.0885	CTD at 300m. Commenced recovery	bridge
990	06:01:00 15/10/2008	CTD 027	24.74432	-40.0885	CTD at the surface	bridge
989	06:03:00 15/10/2008	CTD 027	24.74432	-40.0885	CTD on deck	bridge
988	06:06:00 15/10/2008	Net 019	24.74433	-40.0885	Bongo nets off the deck	bridge
987	06:07:00 15/10/2008	Net 019	24.74432	-40.0885	Bongo nets deployed	bridge
986	06:13:00 15/10/2008	Net 019	24.74432	-40.0885	Bongo nets at 180m. Commenced recovery	bridge
985	06:21:00 15/10/2008	Net 019	24.74432	-40.0885	Bongo nets at the surface	bridge
984	06:23:00 15/10/2008	Net 019	24.74429	-40.0885	Bongo nets on deck	bridge
983	06:39:00 15/10/2008	CTD 028	24.74432	-40.0885	CTD off the deck	bridge
982	06:41:00 15/10/2008	CTD 028	24.74431	-40.0885	CTD deployed	bridge
981	06:43:00 15/10/2008	Net 020	24.74432	-40.0885	Bongo nets off the deck	bridge
980	06:44:00 15/10/2008	Net 020	24.7443	-40.0885	Bongo nets deployed	bridge
979	06:50:00 15/10/2008	Net 020	24.74431	-40.0885	Bongo nets at 180m. Commenced recovery	bridge
978	06:55:00 15/10/2008	CTD 028	24.74431	-40.0885	CTD at 500m. Commenced recovery	bridge
977	06:58:00 15/10/2008	Net 020	24.74431	-40.0885	Bongo nets at the surface	bridge
976	06:59:00 15/10/2008	Net 020	24.74431	-40.0885	Bongo nets on deck	bridge
975	07:22:00 15/10/2008	CTD 028	24.7443	-40.0885	CTD at the surface	bridge
974	07:24:00 15/10/2008	CTD 028	24.7443	-40.0885	CTD on deck	bridge
973	08:59:00 15/10/2008	Station 019 NAG Deep CTD	24.74431	-40.0885		bridge
972	08:59:00 15/10/2008	CTD 029	24.74431	-40.0885	CTD off the deck	bridge
971	09:00:00 15/10/2008	CTD 029	24.7443	-40.0885	CTD Deployed	bridge
970	10:24:00 15/10/2008	CTD 029	24.7443	-40.0885	CTD Deployed - water depth 4690m	bridge
969	10:28:00 15/10/2008	CTD 029	24.74428	-40.0885	Commence hauling	bridge
968	12:51:00 15/10/2008	CTD 029	24.74435	-40.0886	CTD Recovered on deck	bridge
967	13:21:00 15/10/2008	Station 020	24.73829	-40.0701	On station for CTD 028	bridge
966	14:06:00 15/10/2008	CTD 030	24.73821	-40.0701	Gantry unlashed	bridge
965	14:13:00 15/10/2008	CTD 030	24.73814	-40.0701	CTD Deployed	bridge
964	14:14:00 15/10/2008	OPT 008	24.73815	-40.0701	Optics Rig Deployed	bridge

963	14:24:00 15/10/2008	OPT 008	24.73815	-40.0701	Optics Rig @ 180m and recovering	bridge
962	14:27:00 15/10/2008	CTD 030	24.73815	-40.0701	CTD @ 500m and recovering	bridge
961	14:48:00 15/10/2008	OPT 008	24.73819	-40.07	Optics Rig Recovered	bridge
960	14:58:00 15/10/2008	CTD 030	24.73821	-40.0701	CTD Recovered on deck	bridge
959	15:05:00 15/10/2008	Station 020	24.73813	-40.0701	CTD and Gantry secure - off DP	bridge
958	15:18:00 15/10/2008	Station 020	24.72507	-40.0846	Vessel @11.7 knots - off Station resumed passage	bridge
957	05:05:00 16/10/2008	Station 021	22.60754	-40.2733	Off Passage	bridge
956	05:14:00 16/10/2008	Station 021	22.59969	-40.2658	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
955	05:21:00 16/10/2008	CTD 031	22.59967	-40.2659	CTD off the deck	bridge
954	05:23:00 16/10/2008	CTD 031	22.59964	-40.2659	CTD deployed	bridge
953	05:26:00 16/10/2008	Net 021	22.59965	-40.2659	Bongo nets off the deck	bridge
952	05:28:00 16/10/2008	Net 021	22.59966	-40.2659	Bongo nets deployed	bridge
951	05:33:00 16/10/2008	CTD 031	22.59973	-40.2659	CTD at 300m. Commenced recovery	bridge
950	05:34:00 16/10/2008	Net 021	22.59973	-40.2659	Bongo nets at 180m. Commenced recovery	bridge
949	05:42:00 16/10/2008	Net 021	22.59974	-40.2658	Bongo nets at the surface	bridge
948	05:44:00 16/10/2008	Net 021	22.59973	-40.2658	Bongo nets on deck	bridge
947	06:01:00 16/10/2008	CTD 031	22.59971	-40.2659	CTD at the surface	bridge
946	06:03:00 16/10/2008	CTD 031	22.59974	-40.2658	CTD on deck	bridge
945	06:40:00 16/10/2008	CTD 032	22.59976	-40.2658	CTD off the deck	bridge
944	06:41:00 16/10/2008	CTD 032	22.59975	-40.2658	CTD deployed	bridge
943	06:42:00 16/10/2008	Net 022	22.59976	-40.2658	Bongo nets off the deck	bridge
942	06:44:00 16/10/2008	Net 022	22.59973	-40.2658	Bongo nets deployed	bridge
941	06:50:00 16/10/2008	Net 022	22.59967	-40.2658	Bongo nets at 180m. Commenced recovery	bridge
940	06:56:00 16/10/2008	CTD 032	22.59971	-40.2659	CTD at 500m. Commenced recovery	bridge
939	06:59:00 16/10/2008	Net 022	22.5997	-40.2659	Bongo nets at the surface	bridge
938	07:01:00 16/10/2008	Net 022	22.5997	-40.2658	Bongo nets on deck	bridge
937	07:22:00 16/10/2008	CTD 032	22.59975	-40.2658	CTD at the surface	bridge
936	07:24:00 16/10/2008	CTD 032	22.59976	-40.2658	CTD on deck	bridge
935	07:30:00 16/10/2008	Station 021	22.59969	-40.2659	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
934	07:37:00 16/10/2008	Station 021	22.59117	-40.2598	Resumed passage	bridge
933	13:22:00 16/10/2008	Station 022	21.67286	-39.5985	Off passage – reducing speed	bridge
932	13:26:00 16/10/2008	Station 022	21.67323	-39.5964	On Station for CTD 31 - gantry unlashed	bridge
931	13:35:00 16/10/2008	CTD 033	21.67321	-39.5964	CTD Deployed	bridge
930	13:36:00 16/10/2008	OPT 009	21.67322	-39.5964	Optics Rig Deployed	bridge
929	13:46:00 16/10/2008	OPT 009	21.67318	-39.5964	Optics Rig @ 180m and recovering	bridge
928	13:51:00 16/10/2008	CTD 033	21.67319	-39.5964	CTD @ 500m and recovering	bridge
927	14:11:00 16/10/2008	OPT 009	21.67321	-39.5964	Optics Rig Recovered	bridge
926	14:35:00 16/10/2008	CTD 033	21.67314	-39.5964	CTD on deck	bridge
925	14:37:00 16/10/2008	Station 022	21.67316	-39.5964	Gantry lashed and secure	bridge
924	14:41:00 16/10/2008	Station 022	21.67319	-39.5966	Vessel off station	bridge
923	14:45:00 16/10/2008	MVP 003	21.67357	-39.5968	Launch MVP	bridge
922	15:13:00 16/10/2008	Station 022/MVP 003	21.65961	-39.5381	Vessel @11.5 knots throught the water - resumed passage towing MVP	bridge
921	05:00:00 17/10/2008	Station 023/MVP 003	19.72674	-38.2403	Off Passage. Reducing speed for MVP recovery	bridge
920	05:11:00 17/10/2008	MVP 003	19.72286	-38.2298	MVP recovered to deck	bridge
919	05:15:00 17/10/2008	Station 023	19.72243	-38.2301	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
918	05:20:00 17/10/2008	CTD 034	19.7224	-38.2302	CTD off the deck	bridge
917	05:22:00 17/10/2008	CTD 034	19.72243	-38.2302	CTD deployed	bridge
916	05:27:00 17/10/2008	Net 022	19.72239	-38.2302	Bongo nets off the deck	bridge
915	05:28:00 17/10/2008	Net 022	19.72237	-38.2302	Bongo nets deployed	bridge
914	05:34:00 17/10/2008	Net 022	19.72237	-38.2302	Bongo nets at 180m. Commenced recovery	bridge
913	05:34:00 17/10/2008	CTD 034	19.72237	-38.2302	CTD at 300m. Commenced recovery	bridge
912	05:40:00 17/10/2008	Net 022	19.72244	-38.2301	Bongo nets at the surface	bridge
911	05:41:00 17/10/2008	Net 022	19.72235	-38.2301	Bongo nets on deck	bridge
910	06:01:00 17/10/2008	CTD 034	19.72246	-38.2301	CTD at the surface	bridge
909	06:03:00 17/10/2008	CTD 034	19.72246	-38.2301	CTD on deck	bridge

908	06:38:00 17/10/2008	CTD 035	19.72238	-38.2301	CTD off the deck	bridge
907	06:40:00 17/10/2008	CTD 035	19.72238	-38.2301	CTD deployed	bridge
906	06:42:00 17/10/2008	Net 023	19.72242	-38.2302	Bongo nets off the deck	bridge
905	06:44:00 17/10/2008	Net 023	19.72242	-38.2302	Bongo nets deployed	bridge
904	06:50:00 17/10/2008	Net 023	19.72239	-38.2302	Bongo nets at 180m. Commenced recovery	bridge
903	06:54:00 17/10/2008	CTD 035	19.7224	-38.2302	CTD at 500m. Commenced recovery	bridge
902	06:58:00 17/10/2008	Net 023	19.72238	-38.2301	Bongo nets at the surface	bridge
901	06:59:00 17/10/2008	Net 023	19.72236	-38.2301	Bongo nets on deck	bridge
900	07:19:00 17/10/2008	CTD 035	19.72242	-38.2301	CTD at the surface	bridge
899	07:21:00 17/10/2008	CTD 033	19.7224	-38.2301	CTD on deck	bridge
898	07:27:00 17/10/2008	Station 023	19.72237	-38.2301	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
897	07:35:00 17/10/2008	Station 023	19.71155	-38.2236	Resumed passage	bridge
896	13:19:00 17/10/2008	Station 024	18.7929	-37.5892	Off Passage. Reducing speed	bridge
895	13:29:00 17/10/2008	Station 024	18.78863	-37.5779	On Station for CTD 34 - gantry unlashed	bridge
894	13:33:00 17/10/2008	CTD 036	18.78868	-37.5779	CTD deployed	bridge
893	13:35:00 17/10/2008	OPT 010	18.78867	-37.5779	Optics Rig Deployed	bridge
892	13:46:00 17/10/2008	OPT 010	18.7886	-37.5779	Optics Rig @ 180m and recovering	bridge
891	13:48:00 17/10/2008	CTD 036	18.78856	-37.5779	CTD @ 500m and recovering	bridge
890	14:10:00 17/10/2008	OPT 010	18.78855	-37.5779	Optics Rig Recovered	bridge
889	14:34:00 17/10/2008	CTD 036	18.78858	-37.5779	CTD Recovered on deck	bridge
888	14:39:00 17/10/2008	MVP 004	18.78866	-37.5779	Off station - launching MVP	bridge
887	15:00:00 17/10/2008	Station 024	18.77927	-37.5473	Off Station - MVP deployed, proceeding @ 11.5 STW	bridge
886	05:00:00 18/10/2008	Station 025	16.81279	-36.2135	Off Passage	bridge
885	05:02:00 18/10/2008	MVP 004	16.80947	-36.2105	Commenced recovery of MVP	bridge
884	05:09:00 18/10/2008	MVP 004	16.81054	-36.2068	MVP secured on deck	bridge
883	05:14:00 18/10/2008	Station 025	16.81058	-36.2068	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
882	05:20:00 18/10/2008	CTD 037	16.81057	-36.2069	CTD off the deck	bridge
881	05:22:00 18/10/2008	CTD 037	16.81056	-36.2069	CTD deployed	bridge
880	05:27:00 18/10/2008	Net 024	16.81055	-36.2069	Bongo nets off the deck	bridge
879	05:28:00 18/10/2008	Net 024	16.81054	-36.2069	Bongo nets deployed	bridge
878	05:33:00 18/10/2008	CTD 037	16.81051	-36.2069	CTD at 300m. Commenced recovery	bridge
877	05:34:00 18/10/2008	Net 024	16.81051	-36.2068	Bongo nets at 180m. Commenced recovery	bridge
876	05:42:00 18/10/2008	Net 024	16.81052	-36.2068	Bongo nets at the surface	bridge
875	05:43:00 18/10/2008	Net 024	16.81051	-36.2069	Bongo nets on deck	bridge
874	06:04:00 18/10/2008	CTD 037	16.81058	-36.2068	CTD at the surface	bridge
873	06:06:00 18/10/2008	CTD 037	16.81059	-36.2068	CTD on deck	bridge
872	06:43:00 18/10/2008	CTD 038	16.81058	-36.2068	CTD off the deck	bridge
871	06:46:00 18/10/2008	CTD 038	16.81058	-36.2068	CTD deployed	bridge
870	06:48:00 18/10/2008	Net 025	16.8106	-36.2068	Bongo nets off the deck	bridge
869	06:49:00 18/10/2008	Net 025	16.8106	-36.2068	Bongo nets deployed	bridge
868	06:56:00 18/10/2008	Net 025	16.8105	-36.2068	Bongo nets at 180m. Commenced recovery	bridge
867	06:58:00 18/10/2008	CTD 038	16.81052	-36.2068	CTD at 500m. Commenced recovery	bridge
866	07:03:00 18/10/2008	Net 025	16.81058	-36.2068	Bongo nets at the surface	bridge
865	07:04:00 18/10/2008	Net 025	16.81058	-36.2068	Bongo nets on deck	bridge
864	07:29:00 18/10/2008	CTD 038	16.81056	-36.2068	CTD at the surface	bridge
863	07:31:00 18/10/2008	Station 025	16.8106	-36.2068	CTD on deck	bridge
862	08:41:00 18/10/2008	Station 026	16.81049	-36.2068	CTD off the deck	bridge
861	08:43:00 18/10/2008	CTD 039	16.81054	-36.2068	CTD deployed	bridge
860	10:48:00 18/10/2008	CTD 039	16.81051	-36.2068	CTD at 5150m - commence recovery	bridge
859	13:22:00 18/10/2008	CTD 039	16.81052	-36.2068	CTD Recovered on deck.	bridge
858	14:21:00 18/10/2008	Station 27	16.81052	-36.2068	CTD 38 Deployed - going to 300m	bridge
857	14:24:00 18/10/2008	OPT 011	16.81054	-36.2068	Optics Rig Deployed	bridge
856	14:31:00 18/10/2008	CTD 040	16.81053	-36.2068	CTD @ 300m and recovering	bridge
855	14:56:00 18/10/2008	OPT 011	16.81054	-36.2068	Optics Rig Recovered	bridge
854	15:05:00 18/10/2008	CTD 040	16.81093	-36.2071	CTD 038 on deck - gantry secure	bridge
853	15:20:00 18/10/2008	Station 027	16.81095	-36.2072	Off station launching MVP 005	bridge
852	15:40:00 18/10/2008	MVP 005	16.79438	-36.1795	Vessel @11.5 knots - resumed passage, MVP in tow	bridge
851	05:00:00 19/10/2008	Station 028	14.92237	-34.9299	Off Passage. Reducing speed for	bridge

					MVP recovery	
850	05:03:00 19/10/2008	MVP 005	14.91912	-34.9255	Commenced recovery of MVP	bridge
849	05:07:00 19/10/2008	MVP 005	14.91919	-34.9225	MVP at the surface	bridge
848	05:09:00 19/10/2008	MVP 005	14.91918	-34.9221	MVP on deck	bridge
					Vessel Set Up In D.P. Mid-ships	
847	05:10:00 19/10/2008	Station 028	14.9192	-34.9221	gantry unlashed	bridge
846	05:20:00 19/10/2008	CTD 041	14.9192	-34.9221	CTD off the deck	bridge
845	05:22:00 19/10/2008	CTD 041	14.9192	-34.9221	CTD deployed	bridge
844	05:27:00 19/10/2008	Net 026	14.91919	-34.9221	Bongo nets off the deck	bridge
843	05:28:00 19/10/2008	Net 026	14.9192	-34.9221	Bongo nets deployed	bridge
					CTD at 300m. Commenced	
842	05:32:00 19/10/2008	CTD 041	14.9192	-34.9221	recovery	bridge
					Bongo nets at 180m.	
841	05:34:00 19/10/2008	Net 026	14.9192	-34.9221	Commenced recovery	bridge
840	05:42:00 19/10/2008	Net 026	14.91919	-34.9221	Bongo nets at the surface	bridge
839	05:43:00 19/10/2008	Net 026	14.91919	-34.9221	Bongo nets on deck	bridge
838	06:02:00 19/10/2008	CTD 041	14.91919	-34.9221	CTD at the surface	bridge
837	06:04:00 19/10/2008	CTD 041	14.9192	-34.9221	CTD on deck	bridge
836	06:41:00 19/10/2008	CTD 042	14.91922	-34.9221	CTD off the deck	bridge
835	06:43:00 19/10/2008	CTD 042	14.91921	-34.9221	CTD deployed	bridge
834	06:44:00 19/10/2008	Net 027	14.91923	-34.9221	Bongo nets off the deck	bridge
833	06:45:00 19/10/2008	Net 027	14.91921	-34.9221	Bongo nets deployed	bridge
					Bongo nets at 180m.	
832	06:51:00 19/10/2008	Net 027	14.9192	-34.9221	Commenced recovery	bridge
					CTD at 500m. Commenced	
831	06:55:00 19/10/2008	CTD 042	14.91919	-34.9221	recovery	bridge
830	07:00:00 19/10/2008	Net 027	14.91922	-34.9221	Bongo nets at the surface	bridge
829	07:01:00 19/10/2008	Net 027	14.9192	-34.9221	Bongo nets on deck	bridge
828	07:21:00 19/10/2008	CTD 042	14.91918	-34.9221	CTD at the surface	bridge
827	07:23:00 19/10/2008	CTD 042	14.91919	-34.9221	CTD on deck	bridge
					Mid-ships gantry secured. Vessel out of DP and proceeding for	
826	07:30:00 19/10/2008	Station 028	14.91919	-34.9221	STCW calibration	bridge
825	08:22:00 19/10/2008	Station 028	14.91095	-34.9119	Resumed passage	bridge
824	13:18:00 19/10/2008	Station 029	14.10212	-34.3725	Off Passage. Reducing speed	bridge
					On Station for CTD 041 - gantry	
823	13:29:00 19/10/2008	Station 029	14.09316	-34.3601	unlashed in DP	bridge
822	13:40:00 19/10/2008	CTD 043	14.09327	-34.3602	CTD Deployed	bridge
821	13:41:00 19/10/2008	OPT 012	14.09327	-34.3602	Optics Rig Deployed	bridge
					Optics Rig @ 180m and	
820	13:52:00 19/10/2008	OPT 012	14.09322	-34.3602	recovering	bridge
819	13:53:00 19/10/2008	CTD 043	14.09319	-34.3602	CTD @ 500m and recovering	bridge
818	14:18:00 19/10/2008	OPT 012	14.09321	-34.3602	Optics Rig Recovered	bridge
817	14:34:00 19/10/2008	CTD 043	14.09327	-34.3602	CTD Recovered on deck.	bridge
					Gantry stowed and secured -	
816	14:36:00 19/10/2008	Station 029	14.09326	-34.3602	vessel proceeding	bridge
815	14:37:00 19/10/2008	MVP 006	14.09325	-34.3602	Launching MVP	bridge
					MVP deployed (ships speed	
814	14:50:00 19/10/2008	MVP 006	14.0973	-34.3524	11.7kt OG)	bridge
					Vessel @11.7 knots - resumed	
813	15:06:00 19/10/2008	Station 029	14.07494	-34.3145	passage	bridge
					Begin slow down to 1knot for	
812	16:29:00 19/10/2008	MVP 006	13.8439	-34.1707	checking of MVP	bridge
811	16:57:00 19/10/2008	MVP 006	13.79011	-34.1376	Resumed Passage 11.7k	bridge
810	05:00:00 20/10/2008	Station 030	11.82388	-32.834	Off Passage	bridge
809	05:05:00 20/10/2008	MVP 006	11.81847	-32.8253	MVP recovered to deck	bridge
					Vessel Set Up In D.P. Mid-ships	
808	05:11:00 20/10/2008	Station 030	11.82066	-32.8242	gantry unlashed	bridge
807	05:21:00 20/10/2008	CTD 044	11.82056	-32.8242	CTD off the deck	bridge
806	05:23:00 20/10/2008	CTD 044	11.82057	-32.8242	CTD deployed	bridge
805	05:31:00 20/10/2008	Net 028	11.82058	-32.8242	Bongo nets off the deck	bridge
804	05:32:00 20/10/2008	Net 028	11.82057	-32.8242	Bongo nets deployed	bridge
					CTD at 300m. Commenced	
803	05:33:00 20/10/2008	CTD 044	11.82057	-32.8242	recovery	bridge
					Bongo nets at 180m.	
802	05:38:00 20/10/2008	Net 028	11.82057	-32.8242	Commenced recovery	bridge
801	05:46:00 20/10/2008	Net 028	11.82055	-32.8242	Bongo nets at the surface	bridge
800	05:47:00 20/10/2008	Net 028	11.82055	-32.8242	Bongo nets on deck	bridge
799	06:02:00 20/10/2008	CTD 044	11.82056	-32.8242	CTD at the surface	bridge
798	06:04:00 20/10/2008	CTD 044	11.82055	-32.8242	CTD on deck	bridge
797	06:50:00 20/10/2008	CTD 045	11.82061	-32.8242	CTD off the deck	bridge
796	06:52:00 20/10/2008	CTD 045	11.82062	-32.8242	CTD deployed	bridge

795	06:55:00 20/10/2008	Net 029	11.82063	-32.8242	Bongo nets off the deck	bridge
794	06:56:00 20/10/2008	Net 029	11.82063	-32.8242	Bongo nets deployed	bridge
793	07:02:00 20/10/2008	Net 029	11.8206	-32.8242	Bongo nets at 180m. Commenced recovery	bridge
792	07:05:00 20/10/2008	CTD 045	11.8206	-32.8242	CTD at 500m. Commenced recovery	bridge
791	07:09:00 20/10/2008	Net 029	11.82062	-32.8242	Bongo nets at the surface	bridge
790	07:11:00 20/10/2008	Net 029	11.82061	-32.8242	Bongo nets on deck	bridge
789	07:30:00 20/10/2008	CTD 045	11.8206	-32.8242	CTD at the surface	bridge
788	07:32:00 20/10/2008	CTD 045	11.82059	-32.8242	CTD on deck	bridge
787	07:38:00 20/10/2008	Station 030	11.82062	-32.8242	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
786	07:44:00 20/10/2008	Station 030	11.81421	-32.8189	Resumed passage	bridge
785	13:20:00 20/10/2008	Station 031	10.89418	-32.2148	Off Passage. Reducing speed	bridge
784	13:30:00 20/10/2008	Station 031	10.89171	-32.2066	On Station for CTD 044 - gantry unlashed in DP	bridge
783	13:39:00 20/10/2008	CTD 046	10.89154	-32.2065	CTD Deployed	bridge
782	13:41:00 20/10/2008	OPT 013	10.89155	-32.2065	Optics Rig Deployed	bridge
781	13:52:00 20/10/2008	CTD 046	10.89154	-32.2065	CTD @ 500m and recovering	bridge
780	14:16:00 20/10/2008	OPT 013	10.89154	-32.2065	Optics Rig Recovered	bridge
779	14:30:00 20/10/2008	CTD 046	10.89153	-32.2065	CTD Recovered on deck	bridge
778	14:34:00 20/10/2008	Station 031	10.89154	-32.2065	Gantry lashed and secure	bridge
777	14:42:00 20/10/2008	MVP 007	10.89155	-32.2065	MVP Launched while stationary	bridge
776	15:21:00 20/10/2008	MVP 007	10.87993	-32.1772	Vessel @11.5 knots - resumed passage, MVP in tow	bridge
775	17:28:00 20/10/2008	MVP 007	10.52267	-31.9615	Vessel off passage for MVP recovery	bridge
774	17:31:00 20/10/2008	MVP 007	10.51958	-31.9567	Commenced recovery of MVP	bridge
773	17:37:00 20/10/2008	MVP 007	10.5224	-31.9542	MVP at the surface	bridge
772	17:39:00 20/10/2008	MVP 007	10.52279	-31.9541	MVP on deck. Increase to passage speed.	bridge
771	17:44:00 20/10/2008	MVP 007	10.51801	-31.9478	Resumed passage	bridge
770	05:05:00 21/10/2008	Station 032	8.64891	-30.7168	Vessel off passage	bridge
769	05:13:00 21/10/2008	Station 032	8.64382	-30.7084	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
768	05:17:00 21/10/2008	CTD 047	8.64381	-30.7084	CTD off the deck	bridge
767	05:19:00 21/10/2008	CTD 047	8.64381	-30.7084	CTD deployed	bridge
766	05:24:00 21/10/2008	Net 030	8.64383	-30.7084	Bongo nets off the deck	bridge
765	05:25:00 21/10/2008	Net 030	8.64383	-30.7084	Bongo nets deployed	bridge
764	05:31:00 21/10/2008	Net 030	8.64382	-30.7085	Bongo nets at 180m. Commenced recovery	bridge
763	05:31:00 21/10/2008	CTD 047	8.64382	-30.7085	CTD at 300m. Commenced recovery	bridge
762	05:40:00 21/10/2008	Net 030	8.64382	-30.7085	Bongo nets at the surface	bridge
761	05:41:00 21/10/2008	Net 030	8.64381	-30.7085	Bongo nets on deck	bridge
760	05:56:00 21/10/2008	CTD 047	8.64381	-30.7084	CTD at the surface	bridge
759	05:58:00 21/10/2008	CTD 047	8.6438	-30.7084	CTD on deck	bridge
758	05:59:00 21/10/2008	Net 031	8.6438	-30.7084	Bongo nets off the deck	bridge
757	06:00:00 21/10/2008	Net 031	8.6438	-30.7084	Bongo nets deployed	bridge
756	06:06:00 21/10/2008	Net 031	8.64381	-30.7084	Bongo nets at 180m. Commenced recovery	bridge
755	06:14:00 21/10/2008	Net 031	8.6438	-30.7084	Bongo nets at the surface	bridge
754	06:15:00 21/10/2008	Net 031	8.64381	-30.7084	Bongo nets on deck	bridge
753	06:30:00 21/10/2008	CTD 048	8.64379	-30.7084	CTD off the deck	bridge
752	06:32:00 21/10/2008	CTD 048	8.6438	-30.7084	CTD deployed	bridge
751	06:44:00 21/10/2008	CTD 048	8.64378	-30.7084	CTD at 500m. Commenced recovery	bridge
750	07:09:00 21/10/2008	CTD 048	8.64379	-30.7085	CTD at the surface	bridge
749	07:11:00 21/10/2008	CTD 048	8.6438	-30.7085	CTD on deck	bridge
748	07:18:00 21/10/2008	Station 032	8.6438	-30.7085	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
747	07:25:00 21/10/2008	Station 032	8.64381	-30.7085	Resumed passage	bridge
746	13:20:00 21/10/2008	Station 033	7.66277	-30.0593	Off Passage. Reducing speed	bridge
745	13:30:00 21/10/2008	Station 033	7.66277	-30.0593	On Station for CTD 046 - gantry unlashed in DP	bridge
744	13:36:00 21/10/2008	CTD 049	7.66272	-30.0594	CTD Deployed	bridge
743	13:37:00 21/10/2008	OPT 014	7.66271	-30.0594	Optics Rig Deployed	bridge
742	13:41:00 21/10/2008	Net 032	7.66271	-30.0594	Net deployed FWD	bridge
741	13:48:00 21/10/2008	Net 032	7.66271	-30.0594	Net recovered FWD.	bridge
740	13:49:00 21/10/2008	CTD 049	7.66271	-30.0594	CTD @ 500m and recovering	bridge
739	13:51:00 21/10/2008	Net 033	7.66271	-30.0594	Net deployed FWD	bridge
738	13:59:00 21/10/2008	Net 033	7.66269	-30.0594	Net recovered FWD.	bridge

737	14:12:00 21/10/2008	OPT 014	7.6627	-30.0594	Optics Rig Recovered	bridge
736	14:22:00 21/10/2008	CTD 049	7.66269	-30.0594	CTD Recovered on deck.	bridge
735	14:31:00 21/10/2008	MVP 008	7.66269	-30.0594	MVP Launched while stationary	bridge
734	14:44:00 21/10/2008	Station 033	7.6627	-30.0594	Off Station - MVP deployed, increasing to 11.7 SOG	bridge
733	15:00:00 21/10/2008	Station 033	7.62958	-30.0406	Resumed Passage, 11.7k	bridge
732	05:00:00 22/10/2008	Station 034	5.34938	-28.5298	Off Passage	bridge
731	05:05:00 22/10/2008	MVP 008	5.34115	-28.5242	Commenced recovery of MVP	bridge
730	05:09:00 22/10/2008	MVP 008	5.33953	-28.5218	MVP at the surface	bridge
729	05:11:00 22/10/2008	MVP 008	5.33968	-28.5214	MVP on deck	bridge
728	05:12:00 22/10/2008	Station 034	5.33979	-28.5213	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
727	05:19:00 22/10/2008	CTD 050	5.33982	-28.5213	CTD off the deck	bridge
726	05:21:00 22/10/2008	CTD 050	5.33982	-28.5213	CTD deployed	bridge
725	05:24:00 22/10/2008	Net 034	5.33982	-28.5213	Bongo nets off the deck	bridge
724	05:25:00 22/10/2008	Net 034	5.33982	-28.5213	Bongo nets deployed	bridge
723	05:31:00 22/10/2008	CTD 050	5.33982	-28.5213	CTD at 300m. Commenced recovery	bridge
722	05:31:00 22/10/2008	Net 034	5.33982	-28.5213	Bongo nets at 180m. Commenced recovery	bridge
721	05:40:00 22/10/2008	Net 034	5.33982	-28.5213	Bongo nets at the surface	bridge
720	05:41:00 22/10/2008	Net 034	5.33983	-28.5213	Bongo nets on deck	bridge
719	05:57:00 22/10/2008	CTD 050	5.33981	-28.5213	CTD at the surface	bridge
718	06:00:00 22/10/2008	Net 035	5.33981	-28.5213	Bongo nets off the deck	bridge
717	06:00:00 22/10/2008	CTD 050	5.33981	-28.5213	CTD on deck	bridge
716	06:01:00 22/10/2008	Net 035	5.3398	-28.5213	Bongo nets deployed	bridge
715	06:07:00 22/10/2008	Net 035	5.33981	-28.5213	Bongo nets at 180m. Commenced recovery	bridge
714	06:15:00 22/10/2008	Net 035	5.33981	-28.5213	Bongo nets at the surface	bridge
713	06:16:00 22/10/2008	Net 035	5.33981	-28.5213	Bongo nets on deck	bridge
712	06:34:00 22/10/2008	CTD 051	5.33982	-28.5213	CTD off the deck	bridge
711	06:36:00 22/10/2008	CTD 051	5.33982	-28.5213	CTD deployed	bridge
710	06:49:00 22/10/2008	CTD 051	5.33983	-28.5213	CTD at 500m. Commenced recovery	bridge
709	07:16:00 22/10/2008	CTD 051	5.33998	-28.5212	CTD at the surface	bridge
708	07:18:00 22/10/2008	Station 34	5.34002	-28.5212	CTD on deck	bridge
707	08:26:00 22/10/2008	Station 35	5.34002	-28.5212	CTD off the deck (for Japanese Standard)	bridge
706	08:28:00 22/10/2008	CTD 052	5.34048	-28.5212	CTD deployed	bridge
705	09:06:00 22/10/2008	CTD 052	5.34048	-28.5212	CTD at 2, 000m	bridge
704	09:11:00 22/10/2008	CTD 052	5.34048	-28.5212	Commence hauling	bridge
703	09:46:00 22/10/2008	CTD 052	5.3405	-28.5212	CTD on deck	bridge
702	10:33:00 22/10/2008	CTD 053	5.34065	-28.5212	CTD Deployed	bridge
701	11:08:00 22/10/2008	CTD 053	5.3407	-28.5212	CTD @ 2000m	bridge
700	11:13:00 22/10/2008	CTD 053	5.34069	-28.5212	Commence hauling	bridge
699	11:55:00 22/10/2008	CTD 053	5.34068	-28.5212	CTD on deck	bridge
698	11:59:00 22/10/2008	Station 035	5.34067	-28.5212	Mid-ships gantry and CTD secured	bridge
697	12:00:00 22/10/2008	Station 035	5.29061	-28.4935	Vessle out of DP and coming off station	bridge
696	12:16:00 22/10/2008	Station 035	5.28373	-28.489	Vessel @11.7 knots - off Station resumed passage	bridge
695	13:20:00 22/10/2008	Station 036	5.14763	-28.3975	Off Passage. Reducing speed	bridge
694	13:30:00 22/10/2008	Station 036	5.13907	-28.3909	On Station - in DP	bridge
693	13:31:00 22/10/2008	Station 036	5.13908	-28.3909	Gantry unlashed	bridge
692	13:43:00 22/10/2008	CTD 054	5.13905	-28.3909	CTD Deployed	bridge
691	13:44:00 22/10/2008	OPT 015	5.13906	-28.3909	Optics Rig Deployed	bridge
690	13:45:00 22/10/2008	Net 036	5.13905	-28.3909	Net deployed FWD	bridge
689	13:52:00 22/10/2008	Net 036	5.13905	-28.391	Net recovered FWD.	bridge
688	13:56:00 22/10/2008	Net 037	5.13906	-28.391	Net deployed FWD	bridge
687	13:56:00 22/10/2008	OPT 015	5.13906	-28.391	Optics Rig @ 180m and recovering	bridge
686	13:59:00 22/10/2008	CTD 054	5.13906	-28.391	CTD @ 500m and recovering	bridge
685	14:07:00 22/10/2008	Net 037	5.13906	-28.391	Net recovered FWD.	bridge
684	14:21:00 22/10/2008	OPT 014	5.13905	-28.391	Optics Rig Recovered & Secure	bridge
683	14:31:00 22/10/2008	CTD 054	5.13906	-28.391	CTD Recovered on deck	bridge
682	14:36:00 22/10/2008	Station 036	5.13905	-28.391	Gantry and block secure.	bridge
681	14:40:00 22/10/2008	Station 036	5.13906	-28.3909	Off station - streaming MVP	bridge
680	15:00:00 22/10/2008	Station 036 / MVP 009	5.09454	-28.3595	Resume Passage @11.7knt SOG - MVP deployed	bridge
679	05:00:00 23/10/2008	Station 037	2.8005	-26.8571	Off Passage	bridge
678	05:04:00 23/10/2008	MVP 009	2.79325	-26.8529	Commenced recovery of MVP	bridge

677	05:07:00 23/10/2008	MVP 009	2.79109	-26.8529	MVP at the surface	bridge
676	05:09:00 23/10/2008	MVP 009	2.79082	-26.8532	MVP on deck	bridge
675	05:12:00 23/10/2008	Station 037	2.79088	-26.8539	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
674	05:16:00 23/10/2008	CTD 055	2.7909	-26.854	CTD off the deck	bridge
673	05:18:00 23/10/2008	CTD 055	2.7909	-26.854	CTD deployed	bridge
672	05:22:00 23/10/2008	Net 038	2.7909	-26.8539	Bongo nets off the deck	bridge
671	05:23:00 23/10/2008	Net 038	2.7909	-26.8539	Bongo nets deployed	bridge
670	05:29:00 23/10/2008	Net 038	2.7909	-26.8539	Bongo nets at 180m. Commenced recovery	bridge
669	05:29:00 23/10/2008	CTD 055	2.7909	-26.8539	CTD at 300m. Commenced recovery	bridge
668	05:38:00 23/10/2008	Net 038	2.79088	-26.8539	Bongo nets at the surface	bridge
667	05:39:00 23/10/2008	Net 038	2.79087	-26.854	Bongo nets on deck	bridge
666	05:55:00 23/10/2008	CTD 055	2.79155	-26.8543	CTD at the surface	bridge
665	05:57:00 23/10/2008	CTD 055	2.79154	-26.8542	CTD on deck	bridge
664	05:58:00 23/10/2008	Net 039	2.79156	-26.8542	Bongo nets off the deck	bridge
663	05:59:00 23/10/2008	Net 039	2.79153	-26.8542	Bongo nets deployed	bridge
662	06:05:00 23/10/2008	Net 039	2.79154	-26.8542	Bongo nets at 180m. Commenced recovery	bridge
661	06:13:00 23/10/2008	Net 039	2.79155	-26.8542	Bongo nets at the surface	bridge
660	06:14:00 23/10/2008	Net 039	2.79155	-26.8543	Bongo nets on deck	bridge
659	06:32:00 23/10/2008	CTD 056	2.79158	-26.8543	CTD off the deck	bridge
658	06:34:00 23/10/2008	CTD 056	2.79183	-26.8544	CTD deployed	bridge
657	06:47:00 23/10/2008	CTD 056	2.79253	-26.8547	CTD at 500m. Commenced recovery	bridge
656	07:14:00 23/10/2008	CTD 056	2.79323	-26.855	CTD at the surface	bridge
655	07:16:00 23/10/2008	CTD 056	2.7935	-26.8551	CTD on deck	bridge
654	07:22:00 23/10/2008	Station 037	2.79348	-26.8551	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
653	07:29:00 23/10/2008	Station 037	2.78372	-26.8482	Resumed passage	bridge
652	13:20:00 23/10/2008	Station 038	1.8395	-26.2212	Off Passage. Reducing speed for CTD 051	bridge
651	13:30:00 23/10/2008	Station 038	1.82972	-26.2148	On Station for CTD 057 - gantry unlashed in DP	bridge
	13:30:00 23/10/2008	OPT 016	1.82972	-26.2148	Optics Rig Deployed	
650	13:36:00 23/10/2008	Net 038	1.82973	-26.2148	Net deployed FWD.	bridge
649	13:36:00 23/10/2008	CTD 057	1.82973	-26.2148	CTD 057 deployed / Optics rig deployed	bridge
648	13:40:00 23/10/2008	Net 040	1.82989	-26.2149	Net recovered FWD	bridge
647	13:46:00 23/10/2008	OPT 016	1.83031	-26.2152	Optics Rig @ 180m and recovering	bridge
646	13:48:00 23/10/2008	Net 039	1.83073	-26.2154	Net deployed FWD	bridge
645	13:50:00 23/10/2008	CTD 057	1.83066	-26.2154	CTD @ 500m and recovering	bridge
644	13:56:00 23/10/2008	Net 039	1.83097	-26.2156	Net recovered FWD.	bridge
643	14:11:00 23/10/2008	OPT 016	1.83238	-26.2164	Optics Rig Recovered	bridge
642	14:23:00 23/10/2008	CTD 057	1.83453	-26.2177	CTD recovered	bridge
641	14:33:00 23/10/2008	Station 038	1.83367	-26.2172	Off station and streaming MVP	bridge
640	14:40:00 23/10/2008	Station 038 / MVP 010	1.81956	-26.2076	Resume Passage @11.7knt SOG - MVP deployed	bridge
639	18:30:00 23/10/2008	MVP 010	1.1987	-25.795	Reduced ships speed to 10 kts (WT) for MVP	bridge
638	19:13:00 23/10/2008	MVP 010	1.10479	-25.7358	Resumed passage	bridge
637	05:00:00 24/10/2008	Station 039	-0.57633	-24.9982	Off Passage	bridge
636	05:03:00 24/10/2008	MVP 010	-0.58289	-24.9984	Commenced recovery of MVP	bridge
635	05:08:00 24/10/2008	MVP 010	-0.58561	-24.9973	MVP at the surface	bridge
634	05:09:00 24/10/2008	MVP 010	-0.58552	-24.9972	MVP on deck	bridge
633	05:10:00 24/10/2008	Station 039	-0.58545	-24.9971	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
632	05:18:00 24/10/2008	CTD 058	-0.58546	-24.9972	CTD off the deck	bridge
631	05:21:00 24/10/2008	CTD 058	-0.58545	-24.9972	CTD Deployed	bridge
630	05:26:00 24/10/2008	Net 040	-0.58543	-24.9971	Bongo nets off the deck	bridge
629	05:27:00 24/10/2008	Net 040	-0.58533	-24.9971	Bongo nets deployed	bridge
628	05:31:00 24/10/2008	CTD 058	-0.58496	-24.9969	CTD at 300m. Commenced recovery	bridge
627	05:33:00 24/10/2008	Net 040	-0.58479	-24.9968	Bongo nets at 180m. Commenced recovery	bridge
626	05:40:00 24/10/2008	Net 040	-0.58418	-24.9963	Bongo nets at the surface	bridge
625	05:41:00 24/10/2008	Net 040	-0.58409	-24.9962	Bongo nets on deck	bridge
624	05:59:00 24/10/2008	CTD 058	-0.58194	-24.9951	CTD at the surface	bridge
623	06:01:00 24/10/2008	CTD 058	-0.58177	-24.995	CTD on deck	bridge
622	06:34:00 24/10/2008	CTD 059	-0.58162	-24.9949	CTD off the deck	bridge

621	06:36:00 24/10/2008	CTD 059	-0.58122	-24.9948	CTD deployed	bridge
620	06:47:00 24/10/2008	CTD 059	-0.57938	-24.9941	CTD at 500m. Commenced recovery	bridge
619	07:19:00 24/10/2008	CTD 059	-0.57585	-24.9925	CTD at the surface	bridge
618	07:21:00 24/10/2008	CTD 059	-0.57561	-24.9925	CTD on deck	bridge
617	07:26:00 24/10/2008	Station 039	-0.57558	-24.9925	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
616	07:33:00 24/10/2008	Station 039	-0.58604	-24.9921	Resume Passage	bridge
615	12:48:00 24/10/2008	Station 040	-1.61415	-25	Off Passage. Reducing speed for CTD 054	bridge
614	13:00:00 24/10/2008	Station 040	-1.6291	-24.9938	On station for CTD 060 - gantry unlashed	bridge
613	13:09:00 24/10/2008	CTD 060	-1.62909	-24.9938	CTD Deployed	bridge
612	13:11:00 24/10/2008	OPT 017	-1.62899	-24.9939	Optics Rig Deployed	bridge
611	13:23:00 24/10/2008	CTD 060	-1.62747	-24.9949	CTD @ 500m and recovering	bridge
610	13:46:00 24/10/2008	OPT 017	-1.62424	-24.997	Optics Rig Recovered	bridge
609	14:02:00 24/10/2008	Station 040	-1.62051	-24.9995	Gantry lashed and secure	bridge
608	14:05:00 24/10/2008	Station 040	-1.61901	-25.0005	Off station and streaming MVP @ 5 knots for tests	bridge
607	14:59:00 24/10/2008	CTD 060	-1.62133	-24.999	CTD Recovered on deck	bridge
606	15:13:00 24/10/2008	MVP 011	-1.70887	-24.9995	MVP streamed - test complete, increasing to passage speed	bridge
605	15:20:00 24/10/2008	MVP 011	-1.72921	-24.9998	Vessel @11.7 knots - resumed passage	bridge
604	13:15:00 25/10/2008	Station 041	-6.03058	-25.0005	Off passage - Reduce speed for Station 041	bridge
603	13:20:00 25/10/2008	MVP 011	-6.03966	-24.9983	Recovering MVP	bridge
602	13:42:00 25/10/2008	Station 041	-6.05274	-24.9759	On Station for CTD 055 - gantry unlashed in DP	bridge
601	13:42:00 25/10/2008	MVP 011	-6.05274	-24.9759	MVP recovered to deck	bridge
600	13:51:00 25/10/2008	Net 042	-6.05278	-24.9761	Net deployed FWD	bridge
599	13:52:00 25/10/2008	CTD 061	-6.0528	-24.9761	CTD Deployed	bridge
598	13:54:00 25/10/2008	OPT 018	-6.0528	-24.9761	Optics Rig Deployed	bridge
597	13:57:00 25/10/2008	Net 042	-6.05266	-24.9765	Net recovered FWD.	bridge
596	14:01:00 25/10/2008	Net 043	-6.05255	-24.9768	Net deployed FWD	bridge
595	14:02:00 25/10/2008	OPT 018	-6.05249	-24.977	Optics Rig @ 180m and recovering	bridge
594	14:04:00 25/10/2008	CTD 061	-6.05239	-24.9772	CTD @ 500m and recovering	bridge
593	14:08:00 25/10/2008	Net 043	-6.05238	-24.9772	Net recovered FWD.	bridge
592	14:27:00 25/10/2008	OPT 018	-6.05146	-24.9798	Optics Rig Recovered	bridge
591	14:36:00 25/10/2008	CTD 061	-6.05105	-24.981	CTD Recovered on deck	bridge
590	14:40:00 25/10/2008	Station 041	-6.05013	-24.9836	Gantry lashed and secure	bridge
589	14:44:00 25/10/2008	Station 041	-6.04986	-24.9835	Off station launching MVP 012	bridge
588	14:47:00 25/10/2008	MVP 012	-6.05056	-24.9814	MVP deployed - increasing to passage speed 11.7 SOG	bridge
587	14:53:00 25/10/2008	Station 041	-6.06204	-24.9715	Resumed Passage - 11.7 SOG	bridge
586	05:00:00 26/10/2008	Station 042	-8.81954	-25.0001	Off Passage	bridge
585	05:02:00 26/10/2008	MVP 012	-8.82414	-24.9989	Commenced recovery of MVP	bridge
584	05:06:00 26/10/2008	MVP 012	-8.82537	-24.9957	MVP at the surface	bridge
583	05:07:00 26/10/2008	MVP 012	-8.82539	-24.9954	MVP on deck	bridge
582	05:08:00 26/10/2008	Station 042	-8.82538	-24.9953	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
581	05:16:00 26/10/2008	CTD 062	-8.82535	-24.9954	CTD off the deck	bridge
580	05:18:00 26/10/2008	CTD 062	-8.82535	-24.9954	CTD deployed	bridge
579	05:23:00 26/10/2008	Net 044	-8.82536	-24.9954	Bongo nets off the deck	bridge
578	05:24:00 26/10/2008	Net 044	-8.82536	-24.9953	Bongo nets deployed	bridge
577	05:29:00 26/10/2008	CTD 062	-8.82538	-24.9954	CTD at 300m. Commenced recovery	bridge
576	05:30:00 26/10/2008	Net 044	-8.82537	-24.9954	Bongo nets at 180m. Commenced recovery	bridge
575	05:38:00 26/10/2008	Net 044	-8.82535	-24.9954	Bongo nets at the surface	bridge
574	05:39:00 26/10/2008	Net 044	-8.82535	-24.9954	Bongo nets on deck	bridge
573	05:57:00 26/10/2008	CTD 062	-8.82537	-24.9954	CTD at the surface	bridge
572	05:59:00 26/10/2008	CTD 062	-8.82538	-24.9954	CTD on deck	bridge
571	06:01:00 26/10/2008	Net 045	-8.82538	-24.9954	Bongo nets deployed	bridge
570	06:02:00 26/10/2008	Net 045	-8.82538	-24.9954	Bongo nets off the deck	bridge
569	06:07:00 26/10/2008	Net 045	-8.82538	-24.9954	Bongo nets at 180m. Commenced recovery	bridge
568	06:17:00 26/10/2008	Net 045	-8.82537	-24.9954	Bongo nets at the surface	bridge
567	06:18:00 26/10/2008	Net 045	-8.82537	-24.9954	Bongo nets on deck	bridge
566	06:32:00 26/10/2008	CTD 063	-8.82537	-24.9954	CTD off the deck	bridge
565	06:34:00 26/10/2008	CTD 063	-8.82537	-24.9954	CTD deployed	bridge

564	06:46:00 26/10/2008	CTD 063	-8.82537	-24.9954	CTD at 500m. Commenced recovery	bridge
563	07:12:00 26/10/2008	CTD 063	-8.82532	-24.9954	CTD at the surface	bridge
562	07:14:00 26/10/2008	CTD 063	-8.82532	-24.9954	CTD on deck	bridge
561	07:20:00 26/10/2008	Station 042	-8.82534	-24.9954	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
560	07:27:00 26/10/2008	Station 042	-8.83562	-24.9923	Resumed passage	bridge
559	13:15:00 26/10/2008	Station 043	-9.96825	-25.0014	Off Passage. Reducing speed	bridge
558	13:25:00 26/10/2008	Station 043	-9.97521	-24.9995	On Station for CTD 064 - gantry unlashed in DP	bridge
557	13:32:00 26/10/2008	CTD 064	-9.97523	-24.9995	CTD Deployed	bridge
556	13:34:00 26/10/2008	OPT 019	-9.97521	-24.9995	Optics Rig Deployed	bridge
555	13:46:00 26/10/2008	CTD 064	-9.97522	-24.9995	CTD @ 500m and recovering	bridge
554	14:07:00 26/10/2008	OPT 019	-9.97524	-24.9995	Optics Rig Recovered	bridge
553	14:18:00 26/10/2008	CTD 064	-9.97525	-24.9995	CTD Recovered on deck.	bridge
552	14:21:00 26/10/2008	MVP 013	-9.97529	-24.9995	Off station - streaming MVP	bridge
551	14:43:00 26/10/2008	MVP 013	-10.0244	-24.9999	Resumed passage 11.7k SOG - MVP deployed	bridge
550	05:00:00 27/10/2008	Station 044	-12.8333	-25.0032	Off Passage	bridge
549	05:03:00 27/10/2008	MVP 013	-12.8396	-24.9983	Commenced recovery of MVP	bridge
548	05:06:00 27/10/2008	MVP 013	-12.8392	-24.9987	MVP at the surface	bridge
547	05:07:00 27/10/2008	MVP 013	-12.8394	-24.9985	MVP clear of the water	bridge
546	05:09:00 27/10/2008	Station 044	-12.8396	-24.9983	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
545	05:16:00 27/10/2008	CTD 065	-12.8396	-24.9983	CTD off the deck	bridge
544	05:18:00 27/10/2008	CTD 065	-12.8396	-24.9983	CTD deployed	bridge
543	05:23:00 27/10/2008	Net 046	-12.8396	-24.9983	Bongo nets off the deck	bridge
542	05:24:00 27/10/2008	Net 046	-12.8396	-24.9983	Bongo nets deployed	bridge
541	05:28:00 27/10/2008	CTD 065	-12.8396	-24.9983	CTD at 300m. Commenced recovery	bridge
540	05:30:00 27/10/2008	Net 046	-12.8396	-24.9983	Bongo nets at 180m. Commenced recovery	bridge
539	05:39:00 27/10/2008	Net 046	-12.8396	-24.9983	Bongo nets at the surface	bridge
538	05:40:00 27/10/2008	Net 046	-12.8396	-24.9983	Bongo nets on deck	bridge
537	05:58:00 27/10/2008	CTD 065	-12.8396	-24.9983	CTD at the surface	bridge
536	06:00:00 27/10/2008	CTD 065	-12.8396	-24.9983	CTD on deck	bridge
535	06:02:00 27/10/2008	Net 047	-12.8396	-24.9983	Bongo nets off the deck	bridge
534	06:03:00 27/10/2008	Net 047	-12.8396	-24.9983	Bongo nets deployed	bridge
533	06:08:00 27/10/2008	Net 047	-12.8396	-24.9983	Bongo nets at 180m. Commenced recovery	bridge
532	06:16:00 27/10/2008	Net 047	-12.8396	-24.9983	Bongo nets at the surface	bridge
531	06:17:00 27/10/2008	Net 047	-12.8396	-24.9983	Bongo nets on deck	bridge
530	06:33:00 27/10/2008	CTD 066	-12.8396	-24.9983	CTD off the deck	bridge
529	06:35:00 27/10/2008	CTD 066	-12.8396	-24.9983	CTD deployed	bridge
528	06:48:00 27/10/2008	CTD 066	-12.8396	-24.9983	CTD at 500m. Commenced recovery	bridge
527	07:13:00 27/10/2008	CTD 066	-12.8396	-24.9983	CTD at the surface	bridge
526	07:15:00 27/10/2008	CTD 066	-12.8396	-24.9983	CTD on deck	bridge
525	07:23:00 27/10/2008	Station 044	-12.8396	-24.9983	Mid-ships gantry secured. Vessel out of DP and proceeding at 1kt for MVP deployment	bridge
524	07:25:00 27/10/2008	MVP 014	-12.8396	-24.9982	Vessel at 1kt. MVP deployed. Increasing to 5kts	bridge
523	07:29:00 27/10/2008	MVP 014	-12.8412	-24.9938	Completed MVP deployment. Coming up to passage speed.	bridge
522	07:33:00 27/10/2008	Station 044	-12.85	-24.9893	Resumed passage	bridge
521	13:20:00 27/10/2008	Station 045	-13.9869	-24.9998	Off Passage. Reducing speed	bridge
520	13:24:00 27/10/2008	MVP 014	-13.9939	-24.9967	MVP being recovered	bridge
519	13:28:00 27/10/2008	MVP 014	-13.9944	-24.9953	MVP recovered to 1m below the waterline	bridge
518	13:29:00 27/10/2008	Station 045	-13.9944	-24.9953	On Station for CTD 067 - gantry unlashed in DP	bridge
517	13:33:00 27/10/2008	CTD 067	-13.9944	-24.9953	CTD Deployed	bridge
516	13:37:00 27/10/2008	OPT 020	-13.9944	-24.9953	Optics Rig Deployed	bridge
515	13:38:00 27/10/2008	Net 048	-13.9944	-24.9953	Net deployed FWD	bridge
514	13:46:00 27/10/2008	OPT 020	-13.9944	-24.9953	Optics Rig @ 180m and recovering	bridge
513	13:46:00 27/10/2008	Net 048	-13.9944	-24.9953	Net recovered FWD.	bridge
512	13:50:00 27/10/2008	Net 049	-13.9944	-24.9953	Net deployed FWD	bridge
511	13:51:00 27/10/2008	CTD 067	-13.9944	-24.9952	CTD @ 500m and recovering	bridge
510	13:58:00 27/10/2008	Net 049	-13.9944	-24.9952	Net recovered FWD.	bridge
509	14:11:00 27/10/2008	OPT 020	-13.9944	-24.9952	Optics Rig Recovered	bridge

508	14:21:00 27/10/2008	CTD 067	-13.9944	-24.9952	CTD Recovered on deck	bridge
507	14:29:00 27/10/2008	Station 045	-13.9942	-24.9951	Off station - streaming MVP	bridge
506	14:44:00 27/10/2008	MVP 015	-14.0077	-24.9626	MVP deployed (ships speed 11.7kt OG) - resumed passage	bridge
505	19:45:00 27/10/2008	Station 046	-14.9858	-25.0002	Off Passage	bridge
504	19:47:00 27/10/2008	MVP 015	-14.9907	-24.9988	Commenced recovery of MVP	bridge
503	19:55:00 27/10/2008	MVP 015	-14.9933	-24.9943	MVP recovered to 1m below the surface	bridge
502	19:56:00 27/10/2008	Station 046	-14.9934	-24.9944	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
501	20:01:00 27/10/2008	CTD 068	-14.9934	-24.9944	CTD off the deck	bridge
500	20:03:00 27/10/2008	CTD 068	-14.9934	-24.9944	CTD deployed	bridge
499	20:06:00 27/10/2008	CTD 068	-14.9934	-24.9944	CTD at 20m	bridge
498	20:12:00 27/10/2008	CTD 068	-14.9934	-24.9944	Commenced recovery	bridge
497	20:15:00 27/10/2008	CTD 068	-14.9934	-24.9944	CTD at the surface	bridge
496	20:17:00 27/10/2008	CTD 068	-14.9934	-24.9944	CTD on deck	bridge
495	20:24:00 27/10/2008	Station 046	-14.9934	-24.9944	Mid-ships gantry secured. Awaiting traffic to clear before moving off.	bridge
494	20:29:00 27/10/2008	Station 046	-14.9934	-24.9944	Resumed passage	bridge
493	20:30:00 27/10/2008	MVP 016	-14.9934	-24.9944	Commenced streaming MVP	bridge
492	20:36:00 27/10/2008	MVP 016	-14.9965	-24.9872	Completed MVP deployment. Coming up to passage speed.	bridge
491	05:00:00 28/10/2008	Station 047	-16.6279	-25.0001	Off Passage	bridge
490	05:03:00 28/10/2008	MVP 016	-16.6346	-24.998	Commenced recovery of MVP	bridge
489	05:06:00 28/10/2008	MVP 016	-16.6377	-24.9939	MVP at the surface	bridge
488	05:09:00 28/10/2008	MVP 016	-16.6376	-24.994	MVP recovered to deck	bridge
487	05:11:00 28/10/2008	Station 047	-16.6377	-24.9939	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
486	05:18:00 28/10/2008	CTD 069	-16.6377	-24.9939	CTD off the deck	bridge
485	05:20:00 28/10/2008	CTD 069	-16.6377	-24.9939	CTD deployed	bridge
484	05:25:00 28/10/2008	Net 050	-16.6377	-24.9939	Bongo nets off the deck	bridge
483	05:26:00 28/10/2008	Net 050	-16.6377	-24.9939	Bongo nets deployed	bridge
482	05:29:00 28/10/2008	CTD 069	-16.6377	-24.9939	CTD at 300m. Commenced recovery	bridge
481	05:32:00 28/10/2008	Net 050	-16.6377	-24.9939	Bongo nets at 180m. Commenced recovery	bridge
480	05:39:00 28/10/2008	Net 050	-16.6377	-24.9939	Bongo nets at the surface	bridge
479	05:40:00 28/10/2008	Net 050	-16.6377	-24.9939	Bongo nets on deck	bridge
478	05:58:00 28/10/2008	CTD 069	-16.6377	-24.9939	CTD at the surface	bridge
477	06:00:00 28/10/2008	CTD 069	-16.6377	-24.9939	CTD on deck	bridge
476	06:02:00 28/10/2008	Net 051	-16.6377	-24.9939	Bongo nets off the deck	bridge
475	06:03:00 28/10/2008	Net 051	-16.6377	-24.9939	Bongo nets deployed	bridge
474	06:09:00 28/10/2008	Net 051	-16.6377	-24.9939	Bongo nets at 180m. Commenced recovery	bridge
473	06:16:00 28/10/2008	Net 051	-16.6377	-24.9939	Bongo nets at the surface	bridge
472	06:18:00 28/10/2008	Net 051	-16.6377	-24.9939	Bongo nets on deck	bridge
471	06:33:00 28/10/2008	CTD 070	-16.6377	-24.9939	CTD off the deck	bridge
470	06:35:00 28/10/2008	CTD 070	-16.6377	-24.9939	CTD deployed	bridge
469	06:48:00 28/10/2008	CTD 070	-16.6377	-24.9939	CTD at 500m. Commenced recovery	bridge
468	07:17:00 28/10/2008	CTD 070	-16.6377	-24.9939	CTD at the surface	bridge
467	07:19:00 28/10/2008	CTD 070 / Station 047	-16.6377	-24.9939	CTD on deck	bridge
466	08:21:00 28/10/2008	Station 048 / CTD 71	-16.6377	-24.9939	CTD off the deck.	bridge
465	08:23:00 28/10/2008	CTD 71 SG Deep	-16.6377	-24.9939	CTD deployed	bridge
464	09:57:00 28/10/2008	CTD 071	-16.6377	-24.9939	CTD at depth 4530m	bridge
463	09:58:00 28/10/2008	CTD 071	-16.7755	-25.0038	Commence hauling	bridge
462	11:55:00 28/10/2008	CTD 071	-16.7788	-25.0041	CTD @ Surface	bridge
461	11:57:00 28/10/2008	CTD 071	-16.7788	-25.0041	CTD on deck	bridge
460	12:00:00 28/10/2008	CTD 071	-16.7821	-25.0044	CTD and Gantry secure	bridge
459	12:16:00 28/10/2008	CTD 071	-16.7854	-25.0048	Resume Passage	bridge
458	13:20:00 28/10/2008	Station 049	-16.8639	-25.0029	Off Passage. Reducing speed	bridge
457	13:30:00 28/10/2008	Station 049	-16.8755	-24.9962	On Station for CTD 072 - gantry unlashed in DP	bridge
456	13:38:00 28/10/2008	CTD 072	-16.8755	-24.9962	CTD Deployed	bridge
455	13:40:00 28/10/2008	OPT 021	-16.8755	-24.9962	Optics Rig Deployed	bridge
454	13:50:00 28/10/2008	CTD 072	-16.8754	-24.9961	CTD @ 500m and recovering	bridge
453	14:13:00 28/10/2008	OPT 021	-16.8755	-24.9962	Optics Rig Recovered	bridge
452	14:30:00 28/10/2008	CTD 072	-16.8754	-24.9962	CTD Recovered on deck - gantry	bridge

					secure	
451	14:31:00 28/10/2008	Station 049	-16.8754	-24.9962	Off station - streaming MVP	bridge
450	14:42:00 28/10/2008	MVP 017	-16.8689	-24.9722	Resumed passage 11.7k SOG - MVP 017 fully deployed	bridge
449	19:45:00 28/10/2008	Station 050	-17.8512	-25.0002	Off Passage	bridge
448	19:46:00 28/10/2008	MVP 017	-17.8541	-24.9999	Commenced recovery of MVP	bridge
447	19:51:00 28/10/2008	MVP 017	-17.8593	-24.994	MVP recovered to 1m below the surface	bridge
446	19:56:00 28/10/2008	Station 050	-17.8596	-24.9921	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
445	19:59:00 28/10/2008	CTD 073	-17.8596	-24.9921	CTD off the deck	bridge
444	20:00:00 28/10/2008	CTD 073	-17.8596	-24.9921	CTD deployed	bridge
443	20:05:00 28/10/2008	CTD 073	-17.8596	-24.9921	CTD at 20m	bridge
442	20:06:00 28/10/2008	CTD 073	-17.8596	-24.9921	Commenced recovery of CTD	bridge
441	20:08:00 28/10/2008	CTD 073	-17.8596	-24.9921	CTD at the surface	bridge
440	20:09:00 28/10/2008	MVP 018	-17.8596	-24.9921	Commenced deployment of the MVP	bridge
439	20:10:00 28/10/2008	CTD 073	-17.8596	-24.9921	CTD on deck	bridge
438	20:17:00 28/10/2008	Station 050	-17.8597	-24.9921	Mid-ships gantry secured. Vessel out of DP and proceeding at 1kt for MVP deployment	bridge
437	20:19:00 28/10/2008	MVP 018	-17.8596	-24.9917	Commenced deployment of the MVP	bridge
436	20:22:00 28/10/2008	MVP 018	-17.8592	-24.9866	MVP deployed. Increasing to passage speed.	bridge
435	20:27:00 28/10/2008		-17.8668	-24.9731	Vessel blacked out!	bridge
434	20:33:00 28/10/2008	MVP 018	-17.8742	-24.975	Commenced recovery of the MVP	bridge
433	20:44:00 28/10/2008	MVP 018	-17.8694	-24.9773	MVP clear of the water	bridge
432	20:46:00 28/10/2008		-17.8694	-24.9773	Vessel moving off under power	bridge
431	20:55:00 28/10/2008	MVP 019	-17.8726	-24.9841	MVP deployed	bridge
430	20:59:00 28/10/2008	MVP 019	-17.8763	-24.9805	Completed deployment of the MVP. Increasing to passage speed	bridge
429	21:00:00 28/10/2008	Station 050	-17.8778	-24.9787	Resumed passage	bridge
428	03:20:00 29/10/2008	MVP 019	-19.1068	-24.9968	Reduce speed - begin recovering MVP	bridge
427	03:30:00 29/10/2008	Station 051	-19.1231	-24.9962	Vessel on Station in DP	bridge
426	03:30:00 29/10/2008	MVP 019	-19.1231	-24.9962	MVP on deck - vessel in full auto Dp	bridge
425	05:15:00 29/10/2008	CTD 074	-19.1237	-24.9959	CTD off the deck	bridge
424	05:18:00 29/10/2008	CTD 074	-19.1237	-24.9959	CTD deployed	bridge
423	05:23:00 29/10/2008	Net 052	-19.1237	-24.9959	Bongo nets off the deck	bridge
422	05:24:00 29/10/2008	Net 052	-19.1237	-24.9959	Bongo nets deployed	bridge
421	05:27:00 29/10/2008	CTD 074	-19.1237	-24.9959	CTD at 300m. Commenced recovery	bridge
420	05:30:00 29/10/2008	Net 052	-19.1237	-24.9959	Bongo nets at 180m. Commenced recovery	bridge
419	05:38:00 29/10/2008	Net 052	-19.1237	-24.9959	Bongo nets at the surface	bridge
418	05:39:00 29/10/2008	Net 052	-19.1237	-24.9959	Bongo nets on deck	bridge
417	05:58:00 29/10/2008	CTD 074	-19.1237	-24.9959	CTD at the surface	bridge
416	05:59:00 29/10/2008	CTD 074	-19.1237	-24.9959	CTD on deck	bridge
415	06:06:00 29/10/2008	Net 053	-19.1237	-24.9959	Bongo nets off the deck	bridge
414	06:07:00 29/10/2008	Net 053	-19.1237	-24.9959	Bongo nets deployed	bridge
413	06:13:00 29/10/2008	Net 053	-19.1237	-24.9959	Bongo nets at 180m. Commenced recovery	bridge
412	06:20:00 29/10/2008	Net 053	-19.1237	-24.9959	Bongo nets at the surface	bridge
411	06:22:00 29/10/2008	Net 053	-19.1237	-24.9959	Bongo nets on deck	bridge
410	06:33:00 29/10/2008	CTD 075	-19.1237	-24.9959	CTD off the deck	bridge
409	06:35:00 29/10/2008	CTD 075	-19.1237	-24.9959	CTD deployed	bridge
408	06:47:00 29/10/2008	CTD 075	-19.1237	-24.9959	CTD at 500m. Commenced recovery	bridge
407	07:14:00 29/10/2008	CTD 075	-19.1237	-24.9959	CTD at the surface	bridge
406	07:16:00 29/10/2008	CTD 075	-19.1237	-24.9959	CTD on deck	bridge
405	07:22:00 29/10/2008	Station 051	-19.1237	-24.9959	Mid-ships gantry secured. Vessel out of DP and proceeding at 1kt for MVP deployment	bridge
404	07:23:00 29/10/2008	MVP 020	-19.1238	-24.9959	MVP off the deck	bridge
403	07:24:00 29/10/2008	MVP 020	-19.1239	-24.9956	MVP deployed	bridge
402	07:29:00 29/10/2008	MVP 020	-19.1262	-24.9889	Completed deployment of MVP. Increasing to passage speed	bridge
401	07:32:00 29/10/2008	Station 51	-19.1314	-24.9817	Resumed passage	bridge
400	07:32:00 29/10/2008	Station 51	-19.1314	-24.9817	Resumed passage	bridge

					Off Passage. Reducing speed.	
399	13:20:00 29/10/2008	Station 052	-20.2749	-25.0001	Recovering MVP	bridge
398	13:30:00 29/10/2008	MVP 020	-20.2833	-25.0011	MVP Recovered	bridge
					On Station for CTD 076 - gantry	
397	13:34:00 29/10/2008	Station 052	-20.2833	-25.0011	unlashed in DP	bridge
396	13:38:00 29/10/2008	CTD 076	-20.2833	-25.0011	CTD Deployed	bridge
395	13:40:00 29/10/2008	OPT 022	-20.2833	-25.0011	Optics Rig Deployed	bridge
394	13:41:00 29/10/2008	Net 054	-20.2833	-25.0011	Net deployed FWD	bridge
					Optics Rig @ 180m and	
393	13:48:00 29/10/2008	OPT 022	-20.2833	-25.0011	recovering	bridge
392	13:48:00 29/10/2008	Net 054	-20.2833	-25.0011	Net recovered FWD.	bridge
391	13:50:00 29/10/2008	CTD 076	-20.2833	-25.0011	CTD @ 500m and recovering	bridge
390	13:51:00 29/10/2008	Net 055	-20.2833	-25.0011	Net deployed FWD	bridge
389	13:59:00 29/10/2008	Net 055	-20.2833	-25.0011	Net recovered FWD.	bridge
388	14:14:00 29/10/2008	OPT 022	-20.2833	-25.0011	Optics Rig Recovered	bridge
					CTD Recovered on deck - gantry	
387	14:30:00 29/10/2008	CTD 076	-20.2833	-25.0011	lashed, moving off station	bridge
386	14:34:00 29/10/2008	STCM	-20.2827	-25.0021	Reduce to 6 knots for STCM	bridge
385	14:37:00 29/10/2008	STCM	-20.2827	-25.0021	Turn to stbd	bridge
384	14:57:00 29/10/2008	STCM	-20.2812	-25.0036	Turn to Stbd complete	bridge
383	14:58:00 29/10/2008	STCM	-20.2799	-25.0055	Commence turn to Port	bridge
382	15:18:00 29/10/2008	STCM	-20.2818	-25.0057	Complete turn to Port	bridge
381	15:37:00 29/10/2008	MVP 021	-20.2989	-25.0199	Deploy MVP	bridge
					MVP deployed - Passage	
380	15:38:00 29/10/2008	MVP 021	-20.3002	-25.0184	Resumed @ 11.7 SOG	bridge
379	19:45:00 29/10/2008	Station 053	-21.1057	-24.9999	Off Passage	bridge
378	19:47:00 29/10/2008	MVP 021	-21.1108	-25.0009	Commenced recovery of the MVP	bridge
					MVP recovered to 1m below the	
377	19:53:00 29/10/2008	MVP 021	-21.1137	-25.0066	surface	bridge
					Vessel Set Up In D.P. Mid-ships	
376	19:56:00 29/10/2008	Station 053	-21.1135	-25.0072	gantry unlashed	bridge
375	20:00:00 29/10/2008	CTD 077	-21.1135	-25.0072	CTD off the deck	bridge
374	20:01:00 29/10/2008	CTD 077	-21.1135	-25.0072	CTD deployed	bridge
373	20:05:00 29/10/2008	CTD 077	-21.1135	-25.0072	CTD at 20m	bridge
372	20:07:00 29/10/2008	CTD 077	-21.1135	-25.0072	Commenced recovery of CTD	bridge
371	20:10:00 29/10/2008	CTD 077	-21.1135	-25.0072	CTD at the surface	bridge
370	20:12:00 29/10/2008	CTD 077	-21.1135	-25.0072	CTD on deck	bridge
					Mid-ships gantry secured. Vessel out of DP and proceeding at 1kt	
369	20:18:00 29/10/2008	Station 053	-21.1135	-25.0072	for MVP deployment	bridge
					Commenced deployment of the	
368	20:21:00 29/10/2008	MVP 022	-21.1128	-25.0083	MVP	bridge
					Completed deployment of MVP.	
367	20:23:00 29/10/2008	MVP 022	-21.1115	-25.009	Increasing to passage speed	bridge
366	20:35:00 29/10/2008	Station 053	-21.1261	-25.0196	Resumed passage	bridge
365	05:00:00 30/10/2008	Station 054	-22.7752	-25.0024	Off Passage	bridge
364	05:03:00 30/10/2008	MVP 022	-22.7816	-25.0048	Commenced recovery of the MVP	bridge
363	05:08:00 30/10/2008	MVP 022	-22.7849	-25.0088	MVP at the surface	bridge
362	05:09:00 30/10/2008	MVP 022	-22.7852	-25.009	MVP on deck	bridge
					Vessel Set Up In D.P. Mid-ships	
361	05:11:00 30/10/2008	Station 054	-22.7853	-25.0091	gantry unlashed	bridge
360	05:25:00 30/10/2008	CTD 078	-22.7853	-25.0091	CTD off the deck	bridge
359	05:27:00 30/10/2008	CTD 078	-22.7853	-25.0091	CTD deployed	bridge
358	05:32:00 30/10/2008	Net 056	-22.7853	-25.0091	Bongo nets off the deck	bridge
357	05:33:00 30/10/2008	Net 056	-22.7853	-25.0091	Bongo nets deployed	bridge
					CTD at 300m. Commenced	
356	05:37:00 30/10/2008	CTD 078	-22.7853	-25.0091	recovery	bridge
					Bongo nets at 180m.	
355	05:39:00 30/10/2008	Net 056	-22.7853	-25.0091	Commenced recovery	bridge
354	05:48:00 30/10/2008	Net 056	-22.7853	-25.0091	Bongo nets at the surface	bridge
353	05:49:00 30/10/2008	Net 056	-22.7853	-25.0091	Bongo nets on deck	bridge
352	06:04:00 30/10/2008	CTD 078	-22.7853	-25.0091	CTD at the surface	bridge
351	06:06:00 30/10/2008	CTD 078	-22.7853	-25.0091	CTD on deck	bridge
350	06:07:00 30/10/2008	Net 057	-22.7853	-25.0091	Bongo nets off the deck	bridge
349	06:08:00 30/10/2008	Net 057	-22.7853	-25.0091	Bongo nets deployed	bridge
					Bongo nets at 180m.	
348	06:14:00 30/10/2008	Net 057	-22.7853	-25.0091	Commenced recovery	bridge
347	06:23:00 30/10/2008	Net 057	-22.7853	-25.0091	Bongo nets at the surface	bridge
346	06:24:00 30/10/2008	Net 057	-22.7853	-25.0091	Bongo nets on deck	bridge
345	06:39:00 30/10/2008	CTD 079	-22.7853	-25.0091	CTD off the deck	bridge
344	06:41:00 30/10/2008	CTD 079	-22.7853	-25.0091	CTD deployed	bridge
343	06:54:00 30/10/2008	CTD 079	-22.7853	-25.0091	CTD at 500m. Commenced	bridge

					recovery	
342	07:22:00 30/10/2008	CTD 079	-22.7854	-25.0091	CTD at the surface	bridge
341	07:23:00 30/10/2008	CTD 079	-22.7854	-25.0091	CTD on deck	bridge
340	07:29:00 30/10/2008	Station 054	-22.7854	-25.0091	Mid-ships gantry secured. Vessel out of DP and proceeding at 1kt for MVP deployment	bridge
339	07:30:00 30/10/2008	MVP 023	-22.7854	-25.0091	MVP off the deck	bridge
338	07:31:00 30/10/2008	MVP 023	-22.7858	-25.0091	MVP deployed (ships speed 1kt)	bridge
337	07:34:00 30/10/2008	MVP 023	-22.7886	-25.0096	Completed deployment of the MVP. Increasing to passage speed	bridge
336	07:40:00 30/10/2008	Station 054	-22.8033	-25.0088	Resumed passage	bridge
335	13:20:00 30/10/2008	Station 055	-23.9236	-25.0036	Off Passage. Reducing speed	bridge
334	13:24:00 30/10/2008	MVP 023	-23.9319	-25.0018	Being recovering MVP	bridge
333	13:28:00 30/10/2008	MVP 023	-23.9344	-24.9996	MVP at 1m below the surface	bridge
332	13:31:00 30/10/2008	Station 055	-23.9345	-24.9994	On Station for CTD 080 - gantry unlashed in DP	bridge
331	13:37:00 30/10/2008	CTD 080	-23.9345	-24.9994	CTD Deployed	bridge
330	13:39:00 30/10/2008	OPT 023	-23.9345	-24.9994	Optics Rig Deployed	bridge
329	13:48:00 30/10/2008	OPT 023	-23.9345	-24.9994	Optics Rig @ 180m and recovering	bridge
328	13:50:00 30/10/2008	CTD 080	-23.9345	-24.9994	CTD @ 500m and recovering	bridge
327	14:13:00 30/10/2008	OPT 023	-23.9345	-24.9995	Optics Rig Recovered	bridge
326	14:22:00 30/10/2008	CTD 080	-23.9344	-24.9994	CTD Recovered on deck	bridge
325	14:27:00 30/10/2008	Station 055	-23.9345	-24.9995	CTD and Gantry secure	bridge
324	14:30:00 30/10/2008	Float 001	-23.9344	-24.9995	Off station. Vessel @ 5knots awaiting deployment of Science floats.	bridge
323	14:57:00 30/10/2008	Float 001	-23.9783	-24.9994	Float 001 launched	bridge
322	15:09:00 30/10/2008	ARGO 001	-23.9887	-24.9995	ARGO 001 launched	bridge
321	15:10:00 30/10/2008	MVP 024	-24.0174	-25.0034	Increase to 11.7knots SOG - stream MVP	bridge
320	15:14:00 30/10/2008	MVP 024	-23.9914	-25.0006	MVP deployed (ships speed 11.7kt OG)	bridge
319	15:34:00 30/10/2008	Station 055	-24.047	-25.0055	Resumed passage 11.7k SOG - MVP 024 deployed	bridge
318	19:45:00 30/10/2008	Station 056	-24.8548	-25	Off Passage	bridge
317	19:48:00 30/10/2008	MVP 024	-24.8617	-25.0008	Commenced recovery of the MVP	bridge
316	19:53:00 30/10/2008	MVP 024	-24.8668	-25.0028	MVP at the surface	bridge
315	19:55:00 30/10/2008	MVP 024	-24.8675	-25.0033	MVP recovered to deck	bridge
314	19:56:00 30/10/2008	Station 056	-24.8675	-25.0039	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
313	20:01:00 30/10/2008	CTD 081	-24.8675	-25.0037	CTD off the deck	bridge
312	20:02:00 30/10/2008	CTD 081	-24.8676	-25.0034	CTD deployed	bridge
311	20:06:00 30/10/2008	CTD 081	-24.8675	-25.0036	Commenced recovery of CTD	bridge
310	20:09:00 30/10/2008	CTD 081	-24.8676	-25.0034	CTD at the surface	bridge
309	20:10:00 30/10/2008	CTD 081	-24.8676	-25.0035	CTD on deck	bridge
308	20:11:00 30/10/2008	CTD 081	-24.8675	-25.0036	CTD at 20m	bridge
307	20:16:00 30/10/2008	Station 056	-24.8673	-25.0043	Mid-ships gantry secured. Vessel out of DP and proceeding at 1kt for MVP deployment	bridge
306	20:17:00 30/10/2008	MVP 025	-24.8674	-25.0046	MVP off the deck	bridge
305	20:18:00 30/10/2008	MVP 025	-24.8679	-25.0049	MVP deployed (ships speed 1kt)	bridge
304	20:22:00 30/10/2008	MVP 025	-24.8716	-25.006	Completed MVP deployment. Coming up to passage speed.	bridge
303	20:34:00 30/10/2008	Station 056	-24.8968	-25.006	Resumed passage	bridge
302	05:00:00 31/10/2008	Station 057	-26.5445	-24.9983	Off Passage	bridge
301	05:03:00 31/10/2008	MVP 025	-26.5517	-24.9982	Commenced recovery of MVP	bridge
300	05:05:00 31/10/2008	MVP 025	-26.5546	-24.9981	MVP at the surface	bridge
299	05:07:00 31/10/2008	MVP 025	-26.5567	-24.998	MVP on deck	bridge
298	05:10:00 31/10/2008	Station 057	-26.5574	-24.9979	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
297	05:16:00 31/10/2008	CTD 082	-26.5573	-24.9979	CTD off the deck	bridge
296	05:18:00 31/10/2008	CTD 082	-26.5573	-24.9979	CTD deployed	bridge
295	05:23:00 31/10/2008	Net 058	-26.5573	-24.9979	Bongo nets off the deck	bridge
294	05:24:00 31/10/2008	Net 058	-26.5573	-24.9979	Bongo nets deployed	bridge
293	05:28:00 31/10/2008	CTD 082	-26.5573	-24.9979	CTD at 300m. Commenced recovery	bridge
292	05:31:00 31/10/2008	Net 058	-26.5573	-24.9979	Bongo nets at 180m. Commenced recovery	bridge
291	05:40:00 31/10/2008	Net 058	-26.5573	-24.9979	Bongo nets at the surface	bridge
290	05:41:00 31/10/2008	Net 058	-26.5573	-24.9979	Bongo nets on deck	bridge

289	05:58:00 31/10/2008	CTD 082	-26.5573	-24.9979	CTD at the surface	bridge
288	06:00:00 31/10/2008	CTD 082	-26.5573	-24.9979	CTD on deck	bridge
287	06:01:00 31/10/2008	Net 059	-26.5573	-24.9979	Bongo nets off the deck	bridge
286	06:02:00 31/10/2008	Net 059	-26.5573	-24.9979	Bongo nets deployed	bridge
285	06:08:00 31/10/2008	Net 059	-26.5573	-24.9979	Bongo nets at 180m. Commenced recovery	bridge
284	06:18:00 31/10/2008	Net 059	-26.5573	-24.9979	Bongo nets at the surface	bridge
283	06:19:00 31/10/2008	Net 057	-26.5573	-24.9979	Bongo nets on deck	bridge
282	06:37:00 31/10/2008	CTD 083	-26.5573	-24.9979	CTD off the deck	bridge
281	06:39:00 31/10/2008	CTD 083	-26.5573	-24.9979	CTD deployed	bridge
280	06:52:00 31/10/2008	CTD 083	-26.5573	-24.9979	CTD at 500m. Commenced recovery	bridge
279	07:24:00 31/10/2008	CTD 083	-26.5572	-24.9979	CTD at the surface	bridge
278	07:26:00 31/10/2008	CTD 083 / Station 057	-26.5572	-24.9979	CTD on deck	bridge
277	08:31:00 31/10/2008	Station 058 / Deep CTD 084	-26.5573	-24.9979	CTD off the deck	bridge
276	08:33:00 31/10/2008	CTD 084	-26.5573	-24.9979	CTD Deployed (Water depth 4 603m)	bridge
275	09:53:00 31/10/2008	CTD 084	-26.5573	-24.9979	CTD Deployed in 4571m water depth	bridge
274	09:55:00 31/10/2008	CTD 084	-26.5572	-24.9979	Commence hauling	bridge
273	12:45:00 31/10/2008	CTD 084	-26.5573	-24.9979	CTD Recovered on deck	bridge
272	14:00:00 31/10/2008	CTD 085 / Station 059	-26.5572	-24.9979	CTD Deployed	bridge
271	14:02:00 31/10/2008	OPT 024	-26.5572	-24.9979	Optics Rig Deployed	bridge
270	14:05:00 31/10/2008	Net 060	-26.5573	-24.9979	Net deployed FWD	bridge
269	14:12:00 31/10/2008	Net 060	-26.5572	-24.9979	Net recovered FWD.	bridge
268	14:14:00 31/10/2008	CTD 085	-26.5572	-24.9979	CTD @ 300m and recovering	bridge
267	14:15:00 31/10/2008	Net 061	-26.5572	-24.9979	Net deployed FWD	bridge
266	14:22:00 31/10/2008	Net 061	-26.5572	-24.9979	Net recovered FWD.	bridge
265	14:43:00 31/10/2008	CTD 085	-26.5572	-24.998	CTD Recovered on deck	bridge
264	14:48:00 31/10/2008	Station 059	-26.5572	-24.998	CTD and Gantry secure - off station	bridge
263	14:53:00 31/10/2008	ARGO 002	-26.5572	-24.9974	ARGO 002 launched	bridge
262	14:55:00 31/10/2008	Float 002	-26.5973	-24.9799	Float 002 launched	bridge
261	14:57:00 31/10/2008	MVP 026	-26.6037	-24.9801	MVP in water	bridge
260	14:59:00 31/10/2008	MVP 026	-26.6052	-24.9802	MVP deployed	bridge
259	15:04:00 31/10/2008	Station 059	-26.5772	-24.9793	Resumed passage 11.7k SOG	bridge
258	11/01/2008 05:00	Station 060	-28.8658	-26.0273	Off Passage	bridge
257	11/01/2008 05:03	MVP 026	-28.8685	-26.0338	Commenced recovery of MVP	bridge
256	11/01/2008 05:06	MVP 026	-28.8682	-26.0362	MVP at the surface	bridge
255	11/01/2008 05:07	MVP 026	-28.8681	-26.0365	MVP on deck	bridge
254	11/01/2008 05:10	Station 060	-28.8682	-26.0361	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
253	11/01/2008 05:16	CTD 086	-28.8683	-26.0361	CTD off the deck	bridge
252	11/01/2008 05:19	CTD 086	-28.8682	-26.0361	CTD deployed	bridge
251	11/01/2008 05:24	Net 061	-28.8683	-26.0361	Bongo nets off the deck	bridge
250	11/01/2008 05:25	Net 061	-28.8682	-26.0361	Bongo nets deployed	bridge
249	11/01/2008 05:28	CTD 078	-28.8683	-26.0361	CTD at 300m. Commenced recovery	bridge
248	11/01/2008 05:31	Net 061	-28.8683	-26.0361	Bongo nets at 180m. Commenced recovery	bridge
247	11/01/2008 05:40	Net 061	-28.8682	-26.0361	Bongo nets at the surface	bridge
246	11/01/2008 05:41	Net 061	-28.8682	-26.0361	Bongo nets on deck	bridge
245	11/01/2008 05:57	CTD 086	-28.8683	-26.0361	CTD at the surface	bridge
244	11/01/2008 05:59	CTD 086	-28.8683	-26.0361	CTD on deck	bridge
243	11/01/2008 06:31	CTD 087	-28.8683	-26.0361	CTD off the deck	bridge
242	11/01/2008 06:33	CTD 087	-28.8683	-26.0361	CTD deployed	bridge
241	11/01/2008 06:46	CTD 087	-28.8683	-26.0361	CTD at 500m. Commenced recovery	bridge
240	11/01/2008 07:13	CTD 087	-28.8683	-26.0361	CTD at the surface	bridge
239	11/01/2008 07:15	CTD 087	-28.8683	-26.0361	CTD on deck	bridge
238	11/01/2008 07:22	Station 060	-28.8683	-26.0361	Mid-ships gantry secured. Vessel out of DP and proceeding at 1kt for MVP deployment	bridge
237	11/01/2008 07:23	MVP 027	-28.8682	-26.0361	MVP off the deck	bridge
236	11/01/2008 07:24	MVP 027	-28.868	-26.0364	MVP deployed	bridge
235	11/01/2008 07:28	MVP 027	-28.865	-26.0401	Completed deployment of MVP. Increasing to passage speed	bridge
234	11/01/2008 07:36	Station 060	-28.8669	-26.0603	Resume Passage	bridge

233	11/01/2008 13:15	Secure CTD and Waterbottle Annex	-29.732	-27.0939	Reduce speed	bridge
232	11/01/2008 13:20	MVP 027	-29.7338	-27.0956	Haul MVP	bridge
231	11/01/2008 13:25		-29.6342	-26.9529	MVP 1m below water	bridge
230	11/01/2008 13:28		-29.6342	-26.954	Gantry unlashed	bridge
229	11/01/2008 13:40		-29.633	-26.9571	CTD lashed with boards - gantry secure	bridge
228	11/01/2008 13:44	ARGO 3	-29.6319	-26.9581	ARGO 003 launched	bridge
227	11/01/2008 13:46	Float 003	-29.6311	-26.9592	Float 003 launched	bridge
226	11/01/2008 13:47	MVP 028	-29.6306	-26.96	MVP streamed	bridge
225	11/01/2008 13:49	MVP 028	-29.6295	-26.9618	MVP deployed	bridge
224	11/02/2008 06:00	Station 061	-31.1426	-28.876	Off Passage	bridge
223	11/02/2008 06:05	MVP 028	-31.1472	-28.8816	Commenced recovery of the MVP	bridge
222	11/02/2008 06:07	MVP 028	-31.1483	-28.8833	MVP at the surface	bridge
221	11/02/2008 06:09	MVP 028	-31.1491	-28.8847	MVP on deck	bridge
220	11/02/2008 06:14	Station 061	-31.149	-28.8855	Vessel set up in DP	bridge
219	11/02/2008 06:20	Station 061	-31.1489	-28.8856	Station cancelled due to sea conditions and adverse motion of vessel.	bridge
218	11/02/2008 06:28	Station 061	-31.1489	-28.8856	Vessel off DP	bridge
217	11/02/2008 06:35	Station 061	-31.1551	-28.8924	Resumed passage	bridge
216	11/02/2008 14:20	Station 061	-32.1712	-29.8233	Off Passage. Reducing speed	bridge
215	11/02/2008 14:26	Station 061	-32.1794	-29.8255	Gantry unlashed	bridge
214	11/02/2008 14:28	Station 061	-32.1794	-29.8255	On Station for CTD 088 - in DP	bridge
213	11/02/2008 14:47	CTD 088	-32.1794	-29.8255	CTD Deployed	bridge
212	11/02/2008 14:50	OPT 025	-32.1794	-29.8255	Optics Rig Deployed	bridge
211	11/02/2008 14:53	Net 062	-32.1794	-29.8255	Net deployed FWD	bridge
210	11/02/2008 14:57	OPT 025	-32.1794	-29.8255	Optics Rig @ 180m and recovering	bridge
209	11/02/2008 15:01	Net 062	-32.1794	-29.8255	Net recovered FWD.	bridge
208	11/02/2008 15:01	CTD 088	-32.1794	-29.8255	CTD @ 500m and recovering	bridge
207	11/02/2008 15:04	Net 063	-32.1794	-29.8255	Net deployed FWD	bridge
206	11/02/2008 15:13	Net 013	-32.1794	-29.8255	Net recovered FWD.	bridge
205	11/02/2008 15:24	OPT 025	-32.1794	-29.8255	Optics Rig Recovered	bridge
204	11/02/2008 15:34	CTD 088	-32.1795	-29.8255	CTD Recovered on deck	bridge
203	11/02/2008 16:20	CTD 089	-32.1794	-29.8255	CTD Deployed	bridge
202	11/02/2008 16:30	CTD 089	-32.1794	-29.8256	CTD @ 300m and recovering	bridge
201	11/02/2008 17:15	CTD 089	-32.1794	-29.8256	CTD Recovered on deck	bridge
200	11/02/2008 17:22	Station 061	-32.1794	-29.8255	Gantry and CTD lashed	bridge
199	11/02/2008 17:31	ARGO 004	-32.1804	-29.8253	ARGO 004 launched	bridge
198	11/02/2008 17:33	Float 004	-32.2435	-29.9089	Float 004 launched	bridge
197	11/02/2008 17:35	MVP 029	-32.1843	-29.8251	MVP in the water	bridge
196	11/02/2008 17:37	MVP 029	-32.1865	-29.825	MVP deployed	bridge
195	11/02/2008 17:49	Station 061	-32.2068	-29.8458	Resume Passage - 11.7k OG	bridge
194	11/03/2008 06:00	Station 062	-33.7633	-31.9877	Off Passage	bridge
193	11/03/2008 06:02	MVP 029	-33.7668	-31.9925	Commenced recovery of the MVP	bridge
192	11/03/2008 06:07	MVP 029	-33.7686	-32.0007	MVP at the surface	bridge
191	11/03/2008 06:11	MVP 029	-33.7685	-32.0031	MVP on deck	bridge
190	11/03/2008 06:13	Station 062	-33.7683	-32.003	Vessel Set Up In D.P. Mid-ships gantry unlashed	bridge
189	11/03/2008 06:24	CTD 090	-33.7682	-32.003	CTD off the deck	bridge
188	11/03/2008 06:26	CTD 090	-33.7682	-32.003	CTD deployed	bridge
187	11/03/2008 06:28	Net 064	-33.7682	-32.003	Bongo nets off the deck	bridge
186	11/03/2008 06:29	Net 064	-33.7683	-32.003	Bongo nets deployed	bridge
185	11/03/2008 06:35	Net 064	-33.7682	-32.003	Bongo nets at 180m. Commenced recovery	bridge
184	11/03/2008 06:36	CTD 090	-33.7682	-32.003	CTD at 300m. Commenced recovery	bridge
183	11/03/2008 06:43	Net 064	-33.7682	-32.003	Bongo nets at the surface	bridge
182	11/03/2008 06:44	Net 064	-33.7682	-32.003	Bongo nets on deck	bridge
181	11/03/2008 07:03	CTD 090	-33.7682	-32.003	CTD at the surface	bridge
180	11/03/2008 07:04	CTD 090	-33.7682	-32.003	CTD on deck	bridge
179	11/03/2008 07:06	Net 065	-33.7682	-32.003	Bongo nets off the deck	bridge
178	11/03/2008 07:07	Net 065	-33.7682	-32.003	Bongo nets deployed	bridge
177	11/03/2008 07:13	Net 065	-33.7682	-32.003	Bongo nets at 180m. Commenced recovery	bridge
176	11/03/2008 07:21	Net 065	-33.7682	-32.003	Bongo nets at the surface	bridge
175	11/03/2008 07:22	Net 065	-33.7682	-32.003	Bongo nets on deck	bridge
174	11/03/2008 07:41	CTD 091	-33.7682	-32.003	CTD off the deck	bridge
173	11/03/2008 07:43	CTD 091	-33.7682	-32.003	CTD deployed	bridge

172	11/03/2008 07:55	CTD 091	-33.7682	-32.003	CTD at 500m. Commenced recovery	bridge
171	11/03/2008 08:21	CTD 091	-33.7682	-32.0029	CTD at the sur	bridge
170	11/03/2008 08:23	CTD 091	-33.7681	-32.003	CTD on deck	bridge
169	11/03/2008 08:32	Station 062	-33.7683	-32.003	Mid-ships gantry secured. Vessel out of DP and proceeding at 1kt for MVP deployment	bridge
168	11/03/2008 08:36	MVP 030	-33.7703	-32.0032	MVP off the deck	bridge
167	11/03/2008 08:37	MVP 030	-33.7709	-32.0033	MVP deployed	bridge
166	11/03/2008 08:41	MVP 030	-33.7757	-32.0035	Completed deployment of MVP. Increasing to passage speed	bridge
165	11/03/2008 08:45	Station 062	-33.7862	-32.0086	Resume Passage	bridge
164	11/03/2008 14:20	Station 063	-34.5396	-32.9663	Off Passage. Reducing speed	bridge
163	11/03/2008 14:24	MVP 031	-34.5469	-32.975	Begin recovery of MVP	bridge
162	11/03/2008 14:29	MVP 031	-34.5518	-32.9798	MVP 1m below water	bridge
161	11/03/2008 14:32	Station 063	-34.553	-32.9805	On Station for CTD 092 - gantry unlashed in DP	bridge
160	11/03/2008 14:46	CTD 092	-34.5532	-32.9804	CTD Deployed	bridge
159	11/03/2008 14:48	OPT 026	-34.5531	-32.9804	Optics Rig Deployed	bridge
158	11/03/2008 14:52	Net 066	-34.5531	-32.9804	Net deployed FWD	bridge
157	11/03/2008 14:56	OPT 026	-34.5531	-32.9804	Optics Rig @ 180m and recovering	bridge
156	11/03/2008 14:58	Net 066	-34.5531	-32.9804	Net recovered FWD.	bridge
155	11/03/2008 15:01	CTD 092	-34.5531	-32.9804	CTD @ 500m and recovering	bridge
154	11/03/2008 15:04	Net 067	-34.5532	-32.9804	Net deployed FWD	bridge
153	11/03/2008 15:11	Net 067	-34.5532	-32.9804	Net recovered FWD.	bridge
152	11/03/2008 15:22	OPT 026	-34.5532	-32.9804	Optics Rig Recovered	bridge
151	11/03/2008 15:35	CTD 092	-34.5532	-32.9804	CTD on deck.	bridge
150	11/03/2008 15:40	Station 063	-34.5532	-32.9804	CTD and Gantry secure - off station	bridge
149	11/03/2008 15:41	MVP 032	-34.5532	-32.9804	MVP deployed and conducting tests	bridge
148	11/03/2008 18:38	MPV 032	-34.7772	-33.2648	Commenced recovery of the MVP	bridge
147	11/03/2008 18:46	MPV 032	-34.7826	-33.2715	MVP at the surface. Increasing to passage speed.	bridge
146	11/03/2008 18:48	MVP 032	-34.783	-33.2719	MVP on deck	bridge
145	11/03/2008 18:58	Station 063	-34.7973	-33.2908	Resumed passage	bridge
144	11/04/2008 05:05	Station 064	-36.1652	-35.045	Off Passage. Reducing speed	bridge
143	11/04/2008 05:15	Station 064	-36.1732	-35.0542	On Station for CTD 093 - gantry unlashed in DP	bridge
142	11/04/2008 05:22	CTD 093	-36.1732	-35.0542	CTD Deployed	bridge
141	11/04/2008 05:28	Net 068	-36.1732	-35.0542	Bongo net deployed FWD	bridge
140	11/04/2008 05:33	CTD 093	-36.1732	-35.0542	CTD @ 300m and recovering	bridge
139	11/04/2008 05:42	Net 068	-36.1732	-35.0542	Bongo net recovered FWD	bridge
138	11/04/2008 06:01	CTD 093	-36.1732	-35.0542	CTD at the surface	bridge
137	11/04/2008 06:03	CTD 093	-36.1732	-35.0542	CTD on deck	bridge
136	11/04/2008 06:05	Net 069	-36.1732	-35.0542	Bongo nets off the deck	bridge
135	11/04/2008 06:06	Net 069	-36.1732	-35.0542	Bongo nets deployed	bridge
134	11/04/2008 06:12	Net 069	-36.1732	-35.0542	Bongo nets at 180m. Commenced recovery	bridge
133	11/04/2008 06:19	Net 069	-36.1732	-35.0542	Bongo nets on deck	bridge
132	11/04/2008 06:20	Net 069	-36.1732	-35.0542	Bongo nets at the surface	bridge
131	11/04/2008 06:38	CTD 094	-36.1733	-35.0541	CTD off the deck	bridge
130	11/04/2008 06:40	CTD 094	-36.1733	-35.0541	CTD deployed	bridge
129	11/04/2008 06:53	CTD 094	-36.1733	-35.0542	CTD at 500m. Commenced recovery	bridge
128	11/04/2008 07:20	CTD 094	-36.1732	-35.0541	CTD at the surface	bridge
127	11/04/2008 07:22	CTD 094	-36.1732	-35.0541	CTD on deck	bridge
126	11/04/2008 07:30	Station 064	-36.1732	-35.0541	Mid-ships gantry lashed	bridge
125	11/04/2008 07:35		-36.1732	-35.0542	MVP cable deployed (Running off drum on a clump weight)	bridge
124	11/04/2008 08:01		-36.1733	-35.0542	MVP cable fully deployed. Commenced recovery	bridge
123	11/04/2008 09:31		-36.1732	-35.0541	Ceased work on MVP winch for meal break	bridge
122	11/04/2008 10:05		-36.1732	-35.0541	Resumed work on MVP winch	bridge
121	11/04/2008 13:38	MVP calibration	-36.1732	-35.0542	Start recovery of clump weight	bridge
120	11/04/2008 14:18	Station 065	-36.1732	-35.0542	Gantry unlashed	bridge
119	11/04/2008 14:37	CTD 095	-36.1732	-35.0542	CTD Deployed	bridge
118	11/04/2008 14:40	OPT 027	-36.1732	-35.0542	Optics Rig Deployed	bridge
117	11/04/2008 14:43	Net 070	-36.1732	-35.0542	Net deployed FWD	bridge

116	11/04/2008 14:46	OPT 027	-36.1732	-35.0542	Optics Rig @ 180m and recovering	bridge
115	11/04/2008 14:49	Net 070	-36.1732	-35.0542	Net recovered FWD.	bridge
114	11/04/2008 14:51	CTD 095	-36.1731	-35.0542	CTD @ 500m and recovering	bridge
113	11/04/2008 14:53	Net 071	-36.1732	-35.0542	Net deployed FWD	bridge
112	11/04/2008 15:00	Net 071	-36.1732	-35.0542	Net recoverd FWD	bridge
111	11/04/2008 15:12	OPT 027	-36.1732	-35.0542	Optics Rig Recovered	bridge
110	11/04/2008 15:26	CTD 095	-36.1732	-35.0542	CTD Recovered on deck.	bridge
109	11/04/2008 15:29	Station 065	-36.1732	-35.0542	CTD and Gantry secure - off DP, increasing speed	bridge
108	11/04/2008 15:41	Station 065	-36.1799	-35.0698	Resumed passage 11.7k SOG	bridge
107	11/05/2008 05:05	Station 066	-37.9726	-37.4087	Off Passage. Reducing speed	bridge
106	11/05/2008 05:09	Station 066	-37.9691	-37.4131	Gantry unlashed	bridge
105	11/05/2008 05:15	Station 066	-37.9678	-37.4126	On station for CTD 096	bridge
104	11/05/2008 05:25	CTD 096	-37.9662	-37.4112	CTD Deployed	bridge
103	11/05/2008 05:29	Net 072	-37.9677	-37.4126	Bongo net deployed.	bridge
102	11/05/2008 05:31	CTD 096	-37.9677	-37.4126	CTD @ 300m and recovering	bridge
101	11/05/2008 05:42	Net 072	-37.9657	-37.4107	Bongo nets recovered	bridge
100	11/05/2008 05:58	CTD 096	-37.9642	-37.409	CTD Recovered on deck	bridge
99	11/05/2008 06:00	Net 073	-37.9642	-37.4089	Bongo nets off the deck	bridge
98	11/05/2008 06:01	Net 073	-37.9642	-37.4089	Bongo nets deployed	bridge
97	11/05/2008 06:07	Net 073	-37.9643	-37.4079	Bongo nets at 180m. Commenced recovery	bridge
96	11/05/2008 06:15	Net 073	-37.9644	-37.4063	Bongo nets at the surface	bridge
95	11/05/2008 06:15	Net 073	-37.9644	-37.4063	Bongo nets on deck	bridge
94	11/05/2008 06:39	CTD 097	-37.9644	-37.4061	CTD off the deck	bridge
93	11/05/2008 06:41	CTD 097	-37.9644	-37.4058	CTD deployed	bridge
92	11/05/2008 06:54	CTD 097	-37.9633	-37.4039	CTD at 500m. Commenced recovery	bridge
91	11/05/2008 07:18	CTD 097	-37.9606	-37.4003	CTD at the surface	bridge
90	11/05/2008 07:20	CTD 097	-37.9605	-37.4001	CTD on deck	bridge
89	11/05/2008 07:29	Station 066	-37.9605	-37.4001	Mid-ships gantry secured. Vessel out of DP and proceeding	bridge
88	11/05/2008 07:42	Station 066	-37.9757	-37.4213	Resumed passage	bridge
87	11/05/2008 14:05	Station 067	-38.7655	-38.4552	Off Passage. Reducing speed	bridge
86	11/05/2008 14:12	Station 067	-38.7652	-38.4628	Gantry unlashed	bridge
85	11/05/2008 14:17	Station 067	-38.7645	-38.4624	On Station for CTD 090 - gantry unlashed in DP	bridge
84	11/05/2008 14:27	CTD 098	-38.7645	-38.4624	CTD Deployed	bridge
83	11/05/2008 14:31	OPT 028	-38.7645	-38.4624	Optics Rig Deployed	bridge
82	11/05/2008 14:34	Net 074	-38.7638	-38.4611	Net deployed FWD	bridge
81	11/05/2008 14:40	Net 074	-38.7629	-38.4597	Net recoverd FWD	bridge
80	11/05/2008 14:41	CTD 098	-38.7627	-38.4594	CTD @ 500m and recovering	bridge
79	11/05/2008 14:44	Net 075	-38.7621	-38.4584	Net deployed FWD	bridge
78	11/05/2008 14:51	Net 075	-38.7605	-38.456	Net recovered FWD	bridge
77	11/05/2008 15:08	OPT 028	-38.7573	-38.4512	Optics Rig Recovered	bridge
76	11/05/2008 15:14	CTD 098	-38.7565	-38.45	CTD Recovered on deck	bridge
75	11/05/2008 15:26	Float 005	-38.7531	-38.4477	Float 005 launched	bridge
74	11/05/2008 16:12	Station 067	-38.8533	-38.482	Resumed Passage - 11.7 SOG	bridge
73	11/06/2008 14:05	Station 068	-41.466	-42.135	Off Passage - reduce speed	bridge
72	11/06/2008 14:15	Station 068	-41.4741	-42.1455	On Station for CTD 091in DP	bridge
71	11/06/2008 14:17	Station 068	-41.4741	-42.1455	Gantry unlashed	bridge
70	11/06/2008 14:30	CTD 099	-41.4744	-42.1447	CTD deployed	bridge
69	11/06/2008 14:32	OPT 029	-41.4747	-42.1439	Optics Rig Deployed	bridge
68	11/06/2008 14:32	Net 076	-41.4747	-42.1439	Net deployed FWD	bridge
67	11/06/2008 14:40	OPT 029	-41.4758	-42.141	Optics Rig @ 180m and recovering	bridge
66	11/06/2008 14:42	Net 076	-41.4761	-42.1405	Net recoverd FWD	bridge
65	11/06/2008 14:46	Net 077	-41.4767	-42.1395	Net deployed FWD	bridge
64	11/06/2008 14:47	CTD 099	-41.4768	-42.1394	CTD @ 500m and recovering	bridge
63	11/06/2008 14:53	Net 077	-41.4773	-42.1386	Net recoverd FWD	bridge
62	11/06/2008 15:19	CTD 099	-41.4792	-42.1355	CTD Recovered on deck	bridge
61	11/06/2008 15:26	Station 068	-41.4796	-42.1349	Off station	bridge
60	11/06/2008 15:28	ARGO 005	-41.4798	-42.1349	ARGO 005 launched	bridge
59	11/06/2008 15:31	Float 006	-41.4815	-42.1371	Float 006 launched	bridge
58	11/06/2008 16:00	Station 068	-43.9531	-45.6435	Sampling complete - CTD secure in garage, increase to passage, speed 11.7OG	bridge
57	11/06/2008 16:12	Station 068	-41.54	-42.222	Resumed Passage - 11.7 SOG	bridge
56	11/07/2008 05:05	Station 069	-43.2226	-44.6073	Off Passage. Reducing speed	bridge
55	11/07/2008 05:15	Station 069	-43.2265	-44.6134	On Station for CTD 100 - gantry unlashed in DP	bridge

54	11/07/2008 05:24	CTD 100	-43.2266	-44.6134	CTD Deployed	bridge
53	11/07/2008 05:30	Net 078	-43.2266	-44.6134	Bongo net deployed FWD	bridge
52	11/07/2008 05:34	CTD 100	-43.2266	-44.6134	CTD @ 300m and recovering	bridge
51	11/07/2008 05:46	Net 078	-43.2266	-44.6134	Bongo net recovered FWD	bridge
50	11/07/2008 06:00	CTD 100	-43.2266	-44.6134	CTD at the surface	bridge
49	11/07/2008 06:02	CTD 100	-43.2266	-44.6134	CTD Recovered on deck	bridge
48	11/07/2008 06:06	Net 079	-43.2266	-44.6134	Bongo nets off the deck	bridge
47	11/07/2008 06:07	Net 079	-43.2266	-44.6134	Bongo nets deployed	bridge
46	11/07/2008 06:14	Net 079	-43.2266	-44.6134	Bongo nets at 180m. Commenced recovery	bridge
45	11/07/2008 06:23	Net 079	-43.2266	-44.6134	Bongo nets at the surface	bridge
44	11/07/2008 06:24	Net 079	-43.2266	-44.6134	Bongo nets on deck	bridge
43	11/07/2008 06:39	CTD 101	-43.2266	-44.6134	CTD off the deck	bridge
42	11/07/2008 06:42	CTD 101	-43.2266	-44.6134	CTD deployed	bridge
41	11/07/2008 06:56	CTD 101	-43.2266	-44.6134	CTD at 500m. Commenced recovery	bridge
40	11/07/2008 07:23	CTD 101	-43.2266	-44.6134	CTD at the surface	bridge
39	11/07/2008 07:25	CTD 101	-43.2266	-44.6133	CTD on deck	bridge
38	11/07/2008 07:34	Station 069	-43.2266	-44.6134	Mid-ship gantry and CTD secured.	bridge
37	11/07/2008 07:36		-43.2266	-44.6134	MVP wire deployed on a clump weight	bridge
36	11/07/2008 07:52		-43.2266	-44.6133	MVP wire fully deployed. Commenced spooling on.	bridge
35	11/07/2008 08:22		-43.2267	-44.6134	MVP wire and clump weight clear of the water	bridge
34	11/07/2008 08:25		-43.2266	-44.6133	MVP wire deployed on a clump weight	bridge
33	11/07/2008 08:32		-43.2478	-44.6435	MVP wire and clump weight clear of the water	bridge
32	11/07/2008 08:35		-43.2267	-44.6133	Vessel off D.P. and proceeding	bridge
31	11/07/2008 08:47		-43.2422	-44.635	Resumed passage	bridge
30	11/07/2008 09:45		-43.369	-44.8252		bridge
29	11/07/2008 14:04	Station 070	-43.9383	-45.6408	Off Passage - reduce speed	bridge
28	11/07/2008 14:13	CTD 102	-43.945	-45.6488	On station - in DP gantry unlashed	bridge
27	11/07/2008 14:22	CTD 102	-43.9453	-45.6485	CTD Deployed	bridge
26	11/07/2008 14:24	OPT 030	-43.9457	-45.6483	Optics Rig Deployed	bridge
25	11/07/2008 14:32	OPT 030	-43.9469	-45.6476	Optics Rig @ 180m and recovering	bridge
24	11/07/2008 14:36	CTD 102	-43.9473	-45.6473	CTD @ 500m and recovering	bridge
23	11/07/2008 14:58	OPT 030	-43.9499	-45.6456	Optics Rig Recovered	bridge
22	11/07/2008 15:07	CTD 102	-43.9518	-45.6443	CTD Recovered on deck	bridge
21	11/07/2008 15:13	Station 070	-43.9532	-45.6435	CTD and Gantry secure - off station	bridge
20	11/07/2008 15:18	Float 007	-43.9551	-45.6437	Float 007 launched	bridge
19	11/07/2008 15:21	Station 070	-43.958	-45.6464	Increase to passage speed	bridge
18	11/07/2008 15:30	Station 070	-43.9748	-45.6704	Resume Passage - 11.7k OG	bridge
17	11/08/2008 06:05	Station XX	-45.8398	-48.4317	Off Passage	bridge
16	11/08/2008 06:28	Station XX	-45.8371	-48.4281	Vessel Set Up In D.P.	bridge
15	11/08/2008 06:30	Station XX	-45.837	-48.428	Station cancelled due to weather. Vessel off DP and proceeding	bridge
14	11/08/2008 06:51	Station XX	-45.8316	-48.431	Resumed passage	bridge
13	11/08/2008 13:30	Station 071	-46.7878	-49.5342	Off Passage - remove science equipment from bow	bridge
12	11/08/2008 14:00	Station 071	-46.8916	-49.5291	Heave to for Optics rig	bridge
11	11/08/2008 14:12	Station 071	-46.8915	-49.5284	On station	bridge
10	11/08/2008 14:17	OPT 031	-46.8915	-49.5286	Optics Rig Deployed	bridge
9	11/08/2008 14:25	OPT 031	-46.8917	-49.5295	Optics Rig @ 180m and recovering	bridge
8	11/08/2008 14:50	OPT 031	-46.8916	-49.5288	Optics rig on surface	bridge
7	11/08/2008 14:51	OPT 031	-46.8916	-49.5289	Optics Rig Recovered	bridge
6	11/08/2008 15:24	Station 071	-46.8915	-49.5273	Off station - increasing speed	bridge
5	11/08/2008 15:45	Station 071	-46.915	-49.5241	Resume passage	bridge
4	11/08/2008 18:28		-47.4249	-49.9086	Off Passage	bridge
3	11/08/2008 18:34		-47.4442	-49.9033	Vessel standing - head to wind in Auto Head DP	bridge
2	11/08/2008 22:01		-47.404	-49.9172	Coming off DP - to resume passage	bridge
1	11/08/2008 22:29		-47.4181	-49.9067	Resume passage	bridge

Appendix 2: AMT-18 Chlorophyll Calibration Samples

DATE	TIME GMT	LATITUDE	LONGITUDE	Fluorescence (µgL)	TEMP.	SALINITY	VOL. FILTERED	TUBE No.	CHL (µgL)	Dilution	F.No.
06/10/2008	15:30	49 20.88 N	11 40.98 W	0.2790	15.520	35.57	200	1	0.220	10ml	4.50
06/10/2008	15:30	49 20.88 N	11 40.98 W	0.2790	15.520	35.57	200	2	0.280	10ml	5.60
06/10/2008	15:30	49 20.88 N	11 40.98 W	0.2790	15.520	35.57	200	3	0.270	10ml	5.50
07/10/2008	06:56	49 08.93 N	14 39.58 W	0.3500	15.550	35.6	200	4	0.300	10ml	6.10
07/10/2008	06:56	49 08.93 N	14 39.58 W	0.3500	15.550	35.6	200	5	0.200	10ml	4.00
07/10/2008	06:56	49 08.93 N	14 39.58 W	0.3500	15.550	35.6	200	6	0.220	10ml	4.60
07/10/2008	11:51	48 54.54 N	16 02.39 W	0.3220	15.480	35.64	200	7	0.390	10ml	7.90
07/10/2008	11:51	48 54.54 N	16 02.39 W	0.3220	15.480	35.64	200	8	0.370	10ml	7.50
07/10/2008	11:51	48 54.54 N	16 02.39 W	0.3220	15.480	35.64	200	9	0.410	10ml	8.20
07/10/2008	17:58	48 15.14 N	16 51.57 W	0.3570	14.870	35.65	200	10	0.340	10ml	6.80
07/10/2008	17:58	48 15.14 N	16 51.57 W	0.3570	14.870	35.65	200	11	0.350	10ml	7.10
07/10/2008	17:58	48 15.14 N	16 51.57 W	0.3570	14.870	35.65	200	12	0.370	10ml	5.40
08/10/2008	04:05	46 35..28 N	18 41.46 W	0.3620	17.120	35.78	200	13	0.300	10ml	6.00
08/10/2008	04:05	46 35..28 N	18 41.46 W	0.3620	17.120	35.78	200	14	0.240	10ml	4.90
08/10/2008	04:05	46 35..28 N	18 41.46 W	0.3620	17.120	35.78	200	15	0.320	10ml	6.40
08/10/2008	11:52	45 45.14 N	19 30.04 W	0.2780	17.050	35.9	200	16	0.300	10ml	6.10
08/10/2008	11:52	45 45.14 N	19 30.04 W	0.2780	17.050	35.9	200	17	0.290	10ml	5.90
08/10/2008	11:52	45 45.14 N	19 30.04 W	0.2780	17.050	35.9	200	18	0.290	10ml	5.90
08/10/2008	17:19	44 58.67 N	020 11.66 W	0.2570	18.110	35.79	200	19	0.150	10ml	3.00
08/10/2008	17:19	44 58.67 N	020 11.66 W	0.2570	18.110	35.79	200	20	0.180	10ml	3.70
08/10/2008	17:19	44 58.67 N	020 11.66 W	0.2570	18.110	35.79	200	21	0.200	10ml	4.00
09/10/2008	05:11	42.40.56 N	022 11.68 W	0.1900	19.040	35.99	200	22	0.140	10ml	2.80
09/10/2008	05:11	42.40.56 N	022 11.68 W	0.1900	19.040	35.99	200	23	0.140	10ml	2.80
09/10/2008	05:11	42.40.56 N	022 11.68 W	0.1900	19.040	35.99	200	24	0.140	10ml	2.80
09/10/2008	12:02	41 48.36 N	022 55.43 W	0.1840	20.950	36.31	200	25	0.120	10ml	2.60
09/10/2008	12:02	41 48.36 N	022 55.43 W	0.1840	20.950	36.31	200	26	0.120	10ml	2.60
09/10/2008	12:02	41 48.36 N	022 55.43 W	0.1840	20.950	36.31	200	27	0.110	10ml	2.30
09/10/2008	17:23	40 44.40 N	023 47.49 W	0.1810	20.400	36.04	200	28	0.110	10ml	2.20
09/10/2008	17:23	40 44.40 N	023 47.49 W	0.1810	20.400	36.04	200	29	0.120	10ml	2.40
09/10/2008	17:23	40 44.40 N	023 47.49 W	0.1810	20.400	36.04	200	30	0.100	10ml	2.10
10/10/2008	05:02	36 53.62 N	023 18.87 W	0.1660	21.370	36.24	200	31	0.090	10ml	2.00
10/10/2008	05:02	36 53.62 N	023 18.87 W	0.1660	21.370	36.24	200	32	0.110	10ml	2.30
10/10/2008	05:02	36 53.62 N	023 18.87 W	0.1660	21.370	36.24	200	33	0.090	10ml	2.00
10/10/2008	12:15	38 10.82 N	023 52.98 W	0.1630	22.780	36.42	200	34	0.090	10ml	1.90
10/10/2008	12:15	38 10.82 N	023 52.98 W	0.1630	22.780	36.42	200	35	0.080	10ml	1.60
10/10/2008	12:15	38 10.82 N	023 52.98 W	0.1630	22.780	36.42	200	36	0.090	10ml	1.80
11/10/2008	04:57	36 01.22 N	029 42.35 W	0.1580	24.370	36.71	200	37	0.080	10ml	1.80
11/10/2008	04:57	36 01.22 N	029 42.35 W	0.1580	24.370	36.71	200	38	0.080	10ml	1.80
11/10/2008	04:57	36 01.22 N	029 42.35 W	0.1580	24.370	36.71	200	39	0.080	10ml	1.80
11/10/2008	13:16	35 19.47 N	028 28.13 W	0.3220	24.360	36.66	200	40	0.090	10ml	1.90
11/10/2008	13:16	35 19.47 N	028 28.13 W	0.3220	24.360	36.66	200	41	0.080	10ml	1.70
11/10/2008	13:16	35 19.47 N	028 28.13 W	0.3220	24.360	36.66	200	42	0.080	10ml	1.80
11/10/2008	18:41	34 45.00 N	029 07.81 W	0.1520	24.670	36.65	200	43	0.090	10ml	1.90
11/10/2008	18:41	34 45.00 N	029 07.81 W	0.1520	24.670	36.65	200	44	0.090	10ml	1.80
11/10/2008	18:41	34 45.00 N	029 07.81 W	0.1520	24.670	36.65	200	45	0.090	10ml	1.80
12/10/2008	05:02	33 18.45 N	030 47.21 W	0.1370	25.600	36.93	200	46	0.070	10ml	1.30
12/10/2008	05:02	33 18.45 N	030 47.21 W	0.1370	25.600	36.93	200	47	0.070	10ml	1.20
12/10/2008	05:02	33 18.45 N	030 47.21 W	0.1370	25.600	36.93	200	48	0.060	10ml	1.30

12/10/2008	12:48	32 33.58N	031 37.77 W	0.1470	25.500	37.07	200	49	0.050	10ml	1.20
12/10/2008	12:48	32 33.58N	031 37.77 W	0.1470	25.500	37.07	200	50	0.060	10ml	1.30
12/10/2008	12:48	32 33.58N	031 37.77 W	0.1470	25.500	37.07	200	51	0.060	10ml	1.20
12/10/2008	20:19	31 40.79 N	032 37.09 W	0.1440	25.960	37.09	200	52	0.060	10ml	1.20
12/10/2008	20:19	31 40.79 N	032 37.09 W	0.1440	25.960	37.09	200	53	0.050	10ml	1.10
12/10/2008	20:19	31 40.79 N	032 37.09 W	0.1440	25.960	37.09	200	54	0.050	10ml	1.00
13/10/2008	04:59	30 29.49 N	033 55.99 W	0.1530	26.110	37.23	200	55	0.040	10ml	1.00
13/10/2008	04:59	30 29.49 N	033 55.99 W	0.1530	26.110	37.23	200	56	0.050	10ml	1.10
13/10/2008	04:59	30 29.49 N	033 55.99 W	0.1530	26.110	37.23	200	57	0.050	10ml	1.00
13/10/2008	12:21	21 47.89 N	034 41.73 W	0.1440	26.110	37.28	200	58	0.050	10ml	1.00
13/10/2008	12:21	21 47.89 N	034 41.73 W	0.1440	26.110	37.28	200	59	0.050	10ml	1.00
13/10/2008	12:21	21 47.89 N	034 41.73 W	0.1440	26.110	37.28	200	60	0.040	10ml	1.00
13/10/2008	18:58	29 04.00 N	035 29.47 W	0.1490	26.090	37.29	200	61	0.050	10ml	1.00
13/10/2008	18:58	29 04.00 N	035 29.47 W	0.1490	26.090	37.29	200	62	0.040	10ml	1.00
13/10/2008	18:58	29 04.00 N	035 29.47 W	0.1490	26.090	37.29	200	63	0.050	10ml	1.10
14/10/2008	07:34	27 57.38 N	037 02.51 W	0.1400	26.290	37.48	200	64	0.060	10ml	1.30
14/10/2008	07:34	27 57.38 N	037 02.51 W	0.1400	26.290	37.48	200	65	0.060	10ml	1.30
14/10/2008	07:34	27 57.38 N	037 02.51 W	0.1400	26.290	37.48	200	66	0.060	10ml	1.30
14/10/2008	16:41	26 30.71 N	038 14.01 W	0.1410	26.700	37.41	200	67	0.050	10ml	1.10
14/10/2008	16:41	26 30.71 N	038 14.01 W	0.1410	26.700	37.41	200	68	0.070	10ml	1.50
14/10/2008	16:41	26 30.71 N	038 14.01 W	0.1410	26.700	37.41	200	69	0.060	10ml	1.40
15/10/2008	05:00	24 45.43 N	040 0570 W	0.1480	26.740	37.67	200	70	0.010	10ml	2.00
15/10/2008	05:00	24 45.43 N	040 0570 W	0.1480	26.740	37.67	200	71	0.080	10ml	1.80
15/10/2008	05:00	24 45.43 N	040 0570 W	0.1480	26.740	37.67	200	72	0.080	10ml	1.70
15/10/2008	14:01	24 44.29 N	040 04.19 W	0.1470	26.740	37.74	200	73	0.110	10ml	2.20
15/10/2008	14:01	24 44.29 N	040 04.19 W	0.1470	26.740	37.74	200	74	0.110	10ml	2.30
15/10/2008	14:01	24 44.29 N	040 04.19 W	0.1470	26.740	37.74	200	75	0.100	10ml	2.00
15/10/2008	18:14	24 18.72 N	040 32.53 W	0.1860	27.030	37.58	200	76	0.100	10ml	2.20
15/10/2008	18:14	24 18.72 N	040 32.53 W	0.1860	27.030	37.58	200	77	0.070	10ml	1.50
15/10/2008	18:14	24 18.72 N	040 32.53 W	0.1860	27.030	37.58	200	78	0.080	10ml	1.60
16/10/2008	04:57	22 37.22 N	040 16.91 W	0.1480	26.900	37.6	200	79	0.090	10ml	1.90
16/10/2008	04:57	22 37.22 N	040 16.91 W	0.1480	26.900	37.6	200	80	0.090	10ml	1.90
16/10/2008	04:57	22 37.22 N	040 16.91 W	0.1480	26.900	37.6	200	81	0.090	10ml	2.00
16/10/2008	12:24	21 48.89 N	039 42.39 W	0.1490	26.960	37.5	200	82	0.100	10ml	2.10
16/10/2008	12:24	21 48.89 N	039 42.39 W	0.1490	26.960	37.5	200	83	0.100	10ml	2.10
16/10/2008	12:24	21 48.89 N	039 42.39 W	0.1490	26.960	37.5	200	84	0.100	10ml	1.70
16/10/2008	18:07	21 13.40 N	039 17.36 W	0.1400	27.200	37.33	200	85	0.080	10ml	1.70
16/10/2008	18:07	21 13.40 N	039 17.36 W	0.1400	27.200	37.33	200	86	0.090	10ml	1.90
16/10/2008	18:07	21 13.40 N	039 17.36 W	0.1400	27.200	37.33	200	87	0.080	10ml	1.70
17/10/2008	04:54	19 44.85 N	038 14.83 W	0.1380	27.520	36.75	200	88	0.100	10ml	2.00
17/10/2008	04:54	19 44.85 N	038 14.83 W	0.1380	27.520	36.75	200	89	0.100	10ml	2.10
17/10/2008	04:54	19 44.85 N	038 14.83 W	0.1380	27.520	36.75	200	90	0.110	10ml	2.20
17/10/2008	12:14	18 57.48 N	037 42.96 W	0.1430	27.500	36.8	200	91	0.140	10ml	2.90
17/10/2008	12:14	18 57.48 N	037 42.96 W	0.1430	27.500	36.8	200	92	0.140	10ml	2.80
17/10/2008	12:14	18 57.48 N	037 42.96 W	0.1430	27.500	36.8	200	93	0.160	10ml	3.30
17/10/2008	17:37	18 22.54 N	037 18.23 W	0.1450	27.890	36.44	200	94	0.100	10ml	2.20
17/10/2008	17:37	18 22.54 N	037 18.23 W	0.1450	27.890	36.44	200	95	0.100	10ml	2.00
17/10/2008	17:37	18 22.54 N	037 18.23 W	0.1450	27.890	36.44	200	96	0.100	10ml	2.20
18/10/2008	05:56	16 48.57 N	036 12.85 W	0.1450	27.590	36.28	200	97	0.130	10ml	2.70
18/10/2008	05:56	16 48.57 N	036 12.85 W	0.1450	27.590	36.28	200	98	0.120	10ml	2.60
18/10/2008	05:56	16 48.57 N	036 12.85 W	0.1450	27.590	36.28	200	99	0.120	10ml	2.60
18/10/2008	13:52	16 48.63 N	036 12.40 W	0.1460	27.660	36.26	200	100	0.160	10ml	3.30

18/10/2008	13:52	16 48.63 N	036 12.40 W	0.1460	27.660	36.26	200	101	0.160	10ml	3.30
18/10/2008	13:52	16 48.63 N	036 12.40 W	0.1460	27.660	36.26	200	102	0.170	10ml	3.50
18/10/2008	18:09	16 26.07 N	035 57.75 W	0.1570	27.740	36.24	200	103	0.230	10ml	4.70
18/10/2008	18:09	16 26.07 N	035 57.75 W	0.1570	27.740	36.24	200	104	0.240	10ml	5.00
18/10/2008	18:09	16 26.07 N	035 57.75 W	0.1570	27.740	36.24	200	105	0.220	10ml	4.60
19/10/2008	05:03	14 55.15 N	034 36.24 W	0.1650	27.580	36.48	200	106	0.320	10ml	6.70
19/10/2008	05:03	14 55.15 N	034 36.24 W	0.1650	27.580	36.48	200	107	0.330	10ml	6.80
19/10/2008	05:03	14 55.15 N	034 36.24 W	0.1650	27.580	36.48	200	108	0.330	10ml	6.70
19/10/2008	12:05	14 04.32 N	034 18.71 W	0.1600	27.670	36.24	200	109	0.290	10ml	5.90
19/10/2008	12:05	14 04.32 N	034 18.71 W	0.1600	27.670	36.24	200	110	0.300	10ml	6.10
19/10/2008	12:05	14 04.32 N	034 18.71 W	0.1600	27.670	36.24	200	111	0.330	10ml	6.60
19/10/2008	17:56	13 37.18 N	034 01.95 W.	0.1520	28.100	36.46	200	112	0.210	10ml	4.30
19/10/2008	17:56	13 37.18 N	034 01.95 W.	0.1520	28.100	36.46	200	113	0.220	10ml	4.50
19/10/2008	17:56	13 37.18 N	034 01.95 W.	0.1520	28.100	36.46	200	114	0.190	10ml	3.90
20/10/2008	04:51	11 50.37 N	032 50.64 W	0.1470	28.660	35.78	200	115	0.240	10ml	4.80
20/10/2008	04:51	11 50.37 N	032 50.64 W	0.1470	28.660	35.78	200	116	0.190	10ml	3.90
20/10/2008	04:51	11 50.37 N	032 50.64 W	0.1470	28.660	35.78	200	117	0.220	10ml	4.50
20/10/2008	11:50	11 07.97 N	032 22.19 W	0.1550	28.000	35.82	200	118	0.210	10ml	4.30
20/10/2008	11:50	11 07.97 N	032 22.19 W	0.1550	28.000	35.82	200	119	0.180	10ml	3.60
20/10/2008	11:50	11 07.97 N	032 22.19 W	0.1550	28.000	35.82	200	120	0.230	10ml	4.70
20/10/2008	17:28	10 31.17 N	031 57.39 W	0.1400	28.070	35.52	200	121	0.160	10ml	3.30
20/10/2008	17:28	10 31.17 N	031 57.39 W	0.1400	28.070	35.52	200	122	0.150	10ml	3.20
20/10/2008	17:28	10 31.17 N	031 57.39 W	0.1400	28.070	35.52	200	123	0.140	10ml	2.90
21/10/2008	04:54	08 43.34 N	030 43.83 W	0.1380	29.300	33.99	200	124	0.130	10ml	2.60
21/10/2008	04:54	08 43.34 N	030 43.83 W	0.1380	29.300	33.99	200	125	0.130	10ml	2.80
21/10/2008	04:54	08 43.34 N	030 43.83 W	0.1380	29.300	33.99	200	126	0.150	10ml	3.00
21/10/2008	12:18	07 49.84 N	030 10.28 W	0.1480	29.300	34.78	200	127	0.140	10ml	2.90
21/10/2008	12:18	07 49.84 N	030 10.28 W	0.1480	29.300	34.78	200	128	0.120	10ml	2.50
21/10/2008	12:18	07 49.84 N	030 10.28 W	0.1480	29.300	34.78	200	129	0.140	10ml	2.90
21/10/2008	17:03	07 17.44 N	029 48.80 W	0.1340	30.130	34.72	200	130	0.100	10ml	2.20
21/10/2008	17:03	07 17.44 N	029 48.80 W	0.1340	30.130	34.72	200	131	0.100	10ml	2.20
21/10/2008	17:03	07 17.44 N	029 48.80 W	0.1340	30.130	34.72	200	132	0.110	10ml	2.30
22/10/2008	04:29	05 25.03 N	028 34.43 W	0.1420	29.250	33.65	200	133	0.110	10ml	2.40
22/10/2008	04:29	05 25.03 N	028 34.43 W	0.1420	29.250	33.65	200	134	0.120	10ml	2.60
22/10/2008	04:29	05 25.03 N	028 34.43 W	0.1420	29.250	33.65	200	135	0.130	10ml	2.70
22/10/2008	13:26	05 08.34 N	028 23.34 W	0.1450	29.250	33.58	200	136	0.130	10ml	2.60
22/10/2008	13:26	05 08.34 N	028 23.34 W	0.1450	29.250	33.58	200	137	0.120	10ml	2.50
22/10/2008	13:26	05 08.34 N	028 23.34 W	0.1450	29.250	33.58	200	138	0.130	10ml	2.60
22/10/2008	17:27	04 41.18 N	028 05.72W	0.1480	29.280	33.42	200	139	0.140	10ml	3.00
22/10/2008	17:27	04 41.18 N	028 05.72 W	0.1480	29.280	33.42	200	140	0.140	10ml	2.50
22/10/2008	17:27	04 41.18 N	028 05.72 W	0.1480	29.280	33.42	200	141	0.120	10ml	2.80
23/10/2008	04:28	02 57.63 N	026 54.07 W	0.1450	29.110	34.14	200	142	0.130	10ml	2.60
23/10/2008	04:28	02 57.63 N	026 54.07 W	0.1450	29.110	34.14	200	143	0.130	10ml	2.60
23/10/2008	04:28	02 57.63 N	026 54.07 W	0.1450	29.110	34.14	200	144	0.120	10ml	2.60
23/10/2008	11:57	02 03.41 N	026 21.78 W	0.1460	28.320	35.57	200	145	0.180	10ml	3.70
23/10/2008	11:57	02 03.41 N	026 21.78 W	0.1460	28.320	35.57	200	146	0.180	10ml	3.70
23/10/2008	11:57	02 03.41 N	026 21.78 W	0.1460	28.320	35.57	200	147	0.190	10ml	3.90
23/10/2008	16:39	01 28.89 N	025 59.63 W	0.1520	28.330	35.5	200	148	0.150	10ml	3.10
23/10/2008	16:39	01 28.89 N	025 59.63 W	0.1520	28.330	35.5	200	149	0.150	10ml	3.10
23/10/2008	16:39	01 28.89 N	025 59.63 W	0.1520	28.330	35.5	200	150	0.140	10ml	3.10
24/10/2008	04:31	00 29.55 S	024 92.11 W	0.1740	26.990	36	200	151	0.280	10ml	5.60
24/10/2008	04:31	00 29.55 S	024 92.11 W	0.1740	26.990	36	200	152	0.250	10ml	5.00

24/10/2008	04:31	00 29.55 S	024 92.11 W	0.1740	26.990	36	200	153	0.270	10ml	5.40
24/10/2008	13:18	01 37.65 S	024 57.68 W	0.1580	27.430	35.92	200	154	0.120	10ml	2.40
24/10/2008	13:18	01 37.65 S	024 57.68 W	0.1580	27.430	35.92	200	155	0.120	10ml	2.50
24/10/2008	13:18	01 37.65 S	024 57.68 W	0.1580	27.430	35.92	200	156	0.110	10ml	2.40
26/10/2008	04:32	08 44.50 S	024 59.55 W	0.1710	25.870	36.14	200	157	0.110	10ml	2.50
26/10/2008	04:32	08 44.50 S	024 59.55 W	0.1710	25.870	36.14	200	158	0.120	10ml	2.50
26/10/2008	04:32	08 44.50 S	024 59.55 W	0.1710	25.870	36.14	200	159	0.120	10ml	2.50
26/10/2008	11:50	09 42.35 S	025 00.01 W	0.1470	25.000	36.42	200	160	0.090	10ml	1.90
26/10/2008	11:50	09 42.35 S	025 00.01 W	0.1470	25.000	36.42	200	161	0.090	10ml	1.90
26/10/2008	11:50	09 42.35 S	025 00.01 W	0.1470	25.000	36.42	200	162	0.090	10ml	1.90
16/10/2008	16:42	10 25.40 S	024 59.62 W	0.1450	26.000	36.33	200	163	0.090	10ml	1.80
16/10/2008	16:42	10 25.40 S	024 59.62 W	0.1450	26.000	36.33	200	164	0.070	10ml	1.60
16/10/2008	16:42	10 25.40 S	024 59.62 W	0.1450	26.000	36.33	200	165	0.070	10ml	1.50
27/10/2008	04:33	12 45.42 S	025 00.21 W	0.1500	25.360	36.54	200	166	0.080	10ml	1.60
27/10/2008	04:33	12 45.42 S	025 00.21 W	0.1500	25.360	36.54	200	167	0.060	10ml	1.40
27/10/2008	04:33	12 45.42 S	025 00.21 W	0.1500	25.360	36.54	200	168	0.060	10ml	1.40
27/10/2008	12:03	13 44.34 S	025 00.08 W	0.1560	25.020	36.77	200	169	0.060	10ml	1.30
27/10/2008	12:03	13 44.34 S	025 00.08 W	0.1560	25.020	36.77	200	170	0.060	10ml	1.30
27/10/2008	12:03	13 44.34 S	025 00.08 W	0.1560	25.020	36.77	200	171	0.050	10ml	1.20
27/10/2008	17:26	14 32.43 S	024 59.30 W	0.1730	24.870	36.87	200	172	0.050	10ml	1.00
27/10/2008	17:26	14 32.43 S	024 59.30 W	0.1730	24.870	36.87	200	173	0.050	10ml	1.10
27/10/2008	17:26	14 32.43 S	024 59.30 W	0.1730	24.870	36.87	200	174	0.050	10ml	1.00
28/10/2008	04:30	16 32.61 S	024 59.95 W	0.1480	24.740	37.06	200	175	0.050	10ml	1.20
28/10/2008	04:30	16 32.61 S	024 59.95 W	0.1480	24.740	37.06	200	176	0.050	10ml	1.10
28/10/2008	04:30	16 32.61 S	024 59.95 W	0.1480	24.740	37.06	200	177	0.060	10ml	1.20
28/10/2008	12:34	16 43.41 S	024 59.90 W	0.1470	24.800	37.1	200	178	0.050	10ml	1.10
28/10/2008	12:34	16 43.41 S	024 59.90 W	0.1470	24.800	37.1	200	179	0.050	10ml	1.00
28/10/2008	12:34	16 43.41 S	024 59.90 W	0.1470	24.800	37.1	200	180	0.050	10ml	1.10
28/10/2008	16:51	17 17.80 S	024 58.69 W	0.1370	24.810	36.98	200	181	0.030	10ml	0.70
28/10/2008	16:51	17 17.80 S	024 58.69 W	0.1370	24.810	36.98	200	182	0.010	10ml	0.30
28/10/2008	16:51	17 17.80 S	024 58.69 W	0.1370	24.810	36.98	200	183	0.030	10ml	0.80
29/10/2008	04:33	18 07.41 S	024 59.78 W	0.1390	24.350	37.05	200	184	0.060	10ml	1.20
29/10/2008	04:33	18 07.41 S	024 59.78 W	0.1390	24.350	37.05	200	185	0.050	10ml	0.10
29/10/2008	04:33	18 07.41 S	024 59.78 W	0.1390	24.350	37.05	200	186	0.060	10ml	1.30
29/10/2008	11:56	20 00.24 S	025 00.07 W	0.1430	24.640	37.05	200	187	0.040	10ml	0.90
29/10/2008	11:56	20 00.24 S	025 00.07 W	0.1430	24.640	37.05	200	188	0.040	10ml	1.00
29/10/2008	11:56	20 00.24 S	025 00.07 W	0.1430	24.640	37.05	200	189	0.040	10ml	0.90
29/10/2008	17:00	20 37.78 S	024 59.56 W	0.1380	24.960	37.17	200	190	0.050	10ml	1.00
29/10/2008	17:00	20 37.78 S	024 59.56 W	0.1380	24.960	37.17	200	191	0.050	10ml	1.00
29/10/2008	17:00	20 37.78 S	024 59.56 W	0.1380	24.960	37.17	200	192	0.050	10ml	1.00
30/10/2005	11:53	23 39.27 S	024 51.87 W	0.1490	23.340	36.7	200	193	0.070	10ml	1.50
30/10/2005	11:53	23 39.27 S	024 51.87 W	0.1490	23.340	36.7	200	194	0.040	10ml	1.00
30/10/2005	11:53	23 39.27 S	024 51.87 W	0.1490	23.340	36.7	200	195	0.060	10ml	1.40
30/10/2008	16:40	24 15.77 S	024 59.98 W	0.1550	22.000	36.7	200	196	0.080	10ml	1.70
30/10/2008	16:40	24 15.77 S	024 59.98 W	0.1550	22.000	36.7	200	197	0.080	10ml	1.70
30/10/2008	16:40	24 15.77 S	024 59.98 W	0.1550	22.000	36.7	200	198	0.100	10ml	2.00
31/10/2008	04:38	26 23.14 S	024 59.87 W	0.1480	21.300	36.27	200	199	0.090	10ml	2.00
31/10/2008	04:38	26 23.14 S	024 59.87 W	0.1480	21.300	36.27	200	200	0.110	10ml	2.30
31/10/2008	04:38	26 23.14 S	024 59.87 W	0.1480	21.300	36.27	200	201	0.110	10ml	2.40
31/10/2008	11:51	26 33.43 S	024 59.14 W	0.1660	21.230	36.24	200	202	0.110	10ml	2.30
31/10/2008	11:51	26 33.43 S	024 59.14 W	0.1660	21.230	36.24	200	203	0.120	10ml	2.40
31/10/2008	11:51	26 33.43 S	024 59.14 W	0.1660	21.230	36.24	200	204	0.120	10ml	2.40

31/10/2008	16:04	26 47.23 S	024 59.14 W	0.1540	21.110	36.2	200	205	0.110	10ml	2.30
31/10/2008	16:04	26 47.23 S	024 59.14 W	0.1540	21.110	36.2	200	206	0.110	10ml	2.30
31/10/2008	16:04	26 47.23 S	024 59.14 W	0.1540	21.110	36.2	200	207	0.110	10ml	2.30
01/11/2008	04:35	28 48.38 S	025 52.48 W	0.1550	20.260	36.07	200	208	0.150	10ml	3.20
01/11/2008	04:35	28 48.38 S	025 52.48 W	0.1550	20.260	36.07	200	209	0.150	10ml	3.00
01/11/2008	04:35	28 48.38 S	025 52.48 W	0.1550	20.260	36.07	200	210	0.120	10ml	2.60
01/11/2008	12:34	29 33.15 S	026 50.38 W	0.1530	19.390	35.97	200	211	0.150	10ml	3.00
01/11/2008	12:34	29 33.15 S	026 50.38 W	0.1530	19.390	35.97	200	212	0.130	10ml	2.80
01/11/2008	12:34	29 33.15 S	026 50.38 W	0.1530	19.390	35.97	200	213	0.130	10ml	2.80
01/11/2008	16:57	29 56.46S	027 21.00 W	0.1730	19.260	35.96	200	214	0.150	10ml	3.00
01/11/2008	16:57	29 56.46 S	027 21.00 W	0.1730	19.260	35.96	200	215	0.120	10ml	2.50
01/11/2008	16:57	29 56.46 S	027 21.00 W	0.1730	19.260	35.96	200	216	0.130	10ml	2.70
02/11/2008	05:45	31 07.53 S	023 51.25 W	0.1830	18.330	35.78	200	217	0.120	10ml	2.40
02/11/2008	05:45	31 07.53 S	023 51.25 W	0.1830	18.330	35.78	200	218	0.110	10ml	2.20
02/11/2008	05:45	31 07.53 S	023 51.25 W	0.1830	18.330	35.78	200	219	0.110	10ml	2.40
02/11/2008	13:32	32 04.48 S	029 42.47 W	0.1740	18.360	35.75	200	220	0.120	10ml	2.50
02/11/2008	13:32	32 04.48 S	029 42.47 W	0.1740	18.360	35.75	200	221	0.120	10ml	2.50
02/11/2008	13:32	32 04.48 S	029 42.47 W	0.1740	18.360	35.75	200	222	0.110	10ml	2.30
02/11/2008	18:01	32 14.11 S	029 53.68 W	0.1630	16.700	35.62	200	223	0.110	10ml	2.30
02/11/2008	18:01	32 14.11 S	029 53.68 W	0.1630	16.700	35.62	200	224	0.110	10ml	2.40
02/11/2008	18:01	32 14.11 S	029 53.68 W	0.1630	16.700	35.62	200	225	0.110	10ml	2.30
03/11/2008	05:34	33 42.64 S	031 55.72 W	0.2900	16.990	35.73	200	226	0.460	10ml	9.20
03/11/2008	05:34	33 42.64 S	031 55.72 W	0.2900	16.990	35.73	200	227	0.400	10ml	8.00
03/11/2008	05:34	33 42.64 S	031 55.72 W	0.2900	16.990	35.73	200	228	0.370	10ml	7.50
03/11/2008	12:54	34 21.08 S	032 43.91 W	0.2560	17.080	35.68	200	229	0.350	10ml	7.10
03/11/2008	12:54	34 21.08 S	032 43.91 W	0.2560	17.080	35.68	200	230	0.350	10ml	7.00
03/11/2008	12:54	34 21.08 S	032 43.91 W	0.2560	17.080	35.68	200	231	0.290	10ml	6.00
03/11/2008	17:09	34 40.21 S	033 07.80 W	0.2230	17.440	35.59	200	232	0.190	10ml	3.80
03/11/2008	17:09	34 40.21 S	033 07.80 W	0.2230	17.440	35.59	200	233	0.220	10ml	4.40
03/11/2008	17:09	34 40.21 S	033 07.80 W	0.2230	17.440	35.59	200	234	0.200	10ml	4.10
04/11/2008	04:40	35 06.80 S	034.59.00 W	0.3200	15.690	35.57	200	235	0.380	10ml	7.70
04/11/2008	04:40	35 06.80 S	034.59.00 W	0.3200	15.690	35.57	200	236	0.320	10ml	6.50
04/11/2008	04:40	35 06.80 S	034.59.00 W	0.3200	15.690	35.57	200	237	0.340	10ml	6.90
04/11/2008	13:08	36 10.38 S	035 03.46 W	0.2660	15.910	35.55	200	238	0.260	10ml	5.20
04/11/2008	13:08	36 10.38 S	035 03.46 W	0.2660	15.910	35.55	200	239	0.300	10ml	6.10
04/11/2008	13:08	36 10.38 S	035 03.46 W	0.2660	15.910	35.55	200	240	0.290	10ml	5.80
04/11/2008	17:53	36 29.04 S	035 27.51 W	0.3110	16.360	35.55	200	241	1.330	10ml	26.57
04/11/2008	17:53	36 29.04 S	035 27.51 W	0.3110	16.360	35.55	200	242	1.290	10ml	25.80
04/11/2008	17:53	36 29.04 S	035 27.51 W	0.3110	16.360	35.55	200	243	1.190	10ml	23.80
05/11/2008	04:43	37 56.00 S	037 21.54 W	0.5830	15.870	35.56	200	244	1.120	10ml	22.40
05/11/2008	04:43	37 56.00 S	037 21.54 W	0.5830	15.870	35.56	200	245	1.060	10ml	21.40
05/11/2008	04:43	37 56.00 S	037 21.54 W	0.5830	15.870	35.56	200	246	1.160	10ml	23.20
05/11/2008	12:54	38 37.64 S	038 16.20 W	0.4780	15.090	35.72	200	247	0.660	10ml	0.68
05/11/2008	12:54	38 37.64 S	038 16.20 W	0.4780	15.090	35.72	200	248	0.670	10ml	0.07
05/11/2008	12:54	38 37.64 S	038 16.20 W	0.4780	15.090	35.72	200	249	0.670	10ml	0.07
05/11/2008	18:04	31 05.75 S	038 50.58 W	0.4230	15.640	35.85	200	250	0.670	10ml	13.70
05/11/2008	18:04	31 05.75 S	038 50.58 W	0.4230	15.640	35.85	200	251	0.680	10ml	13.80
05/11/2008	18:04	31 05.75 S	038 50.58 W	0.4230	15.640	35.85	200	252	0.690	10ml	13.90
06/11/2008	12:59	41 19.88 S	041 55.79 W	0.4340	12.010	34.58	200	253	0.680	10ml	13.80
06/11/2008	12:59	41 19.88 S	041 55.79 W	0.4340	12.010	34.58	200	254	0.690	10ml	13.90
06/11/2008	12:59	41 19.88 S	041 55.79 W	0.4340	12.010	34.58	200	255	0.650	10ml	0.65
06/11/2008	15:52	41 30.63 S	042 10.74 W	0.6560	11.400	34.46	200	256	2.690	10ml	54.00

06/11/2008	15:52	41 30.63 S	042 10.74 W	0.6560	11.400	34.46	200	257	2.320	10ml	46.40
06/11/2008	15:52	41 30.63 S	042 10.74 W	0.6560	11.400	34.46	200	258	2.720	10ml	54.50
07/11/2008	04:40	43 10.70 S	044 32.50W	1.3350	10.500	34.14	200	259	3.740	10ml	74.80
07/11/2008	04:40	43 10.70 S	044 32.50W	1.3350	10.500	34.14	200	26	3.770	10ml	75.60
07/11/2008	04:40	43 10.70 S	044 32.50W	1.3350	10.500	34.14	200	261	3.580	10ml	71.70
07/11/2008	13:19	43 50.88 S	045 50.22 W	0.7710	10.300	34.38	200	262	3.230	10ml	64.70
07/11/2008	13:19	43 50.88 S	045 50.22 W	0.7710	10.300	34.38	200	263	3.180	10ml	63.70
07/11/2008	13:19	43 50.88 S	045 50.22 W	0.7710	10.300	34.38	200	264	3.050	10ml	61.10
07/11/2008	17:23	44 14.22 S	046 82.97 W	0.8000	10.940	34.43	200	265	2.970	10ml	59.50
07/11/2008	17:23	44 14.22 S	046 82.97 W	0.8000	10.940	34.43	200	266	3.070	10ml	61.40
07/11/2008	17:23	44 14.22 S	046 82.97 W	0.8000	10.940	34.43	200	267	2.970	10ml	59.60

Appendix 3a: Azores Sampling for Zooplankton Species:
AMT-18 MesozooplanktonNet Sampling Log - Portuguese samples

Date	Year Day	Sample ID	Depth	Start Flow	End Flow	Net Vol (Cu M)	Sample Prop'n
7/10/2008	281	AMT18-001	175	4150	4790	27.65	Half net
8/10/2008	282	AMT18-002	175	4790	5310	22.47	Half net
9/10/2008	283	AMT18-003	175	5310	6020	30.68	Half net
10/10/2008	284	AMT18-004	175	6020	6310	12.53	Half net
11/10/2008	285	AMT18-005	175	6310	7256	40.87	Half net
12/10/2008	286	AMT18-006	175	8190	8745	23.98	Whole Net
13/10/2008	287	AMT18-007	175	9450	10435	42.56	Whole Net
14/10/2008	288	AMT18-008	175	11425	12410	42.56	Whole Net
15/10/2008	289	AMT18-009	175	3460	4510	45.37	Whole Net
16/10/2008	290	AMT18-010	175	4510	5530	44.07	Whole Net
17/10/2008	291	AMT18-011	175	6685	7440	32.62	Whole Net
18/10/2008	292	AMT18-012	175	8370	9690	57.03	Whole Net
19/10/2008	293	AMT18-013	175	1130	2495	58.98	Whole Net
20/10/2008	294	AMT18-014	175	3985	4892	39.19	Whole Net
21/10/2008	295	AMT18-015	175	5800	6450	28.08	Whole Net
22/10/2008	296	AMT18-016	175	7160	7870	30.68	Whole Net
23/10/2008	297	AMT18-017	175	8550	9460	39.32	Whole Net

Flow Meter Conversion:

Blade length	25.000	mm
Blade depth	16	mm
Rotor diameter	76.000	mm
Rotor Circumference	238.761	mm
Blade fraction	9.550	mm
1 rev pitch	0.153	m
1 rev vol	0.043	cu m

Appendix 3b: Azores Sampling for 18O and 13C:

Azores Samples for O18 and 13C

8th October 2008

CTD_008		CTD_010	
CTD Bottle	Depth	CTD Bottle	Depth
24	Surface	23	Surface
8	54	12	55
4	90	5	98
3	120	4	130
2	200	2	200
1	300	1	300

9th October 2008

CTD_011		10th October 2008 CTD_013	
CTD Bottle	Depth	CTD Bottle	Depth
23	Surface	23	Surface
14	40	14	43
10	95	10	102
6	143	6	153
2	200	2	200
1	300	1	300

11th October 2008

CTD_015		12th October 2008 CTD_018	
CTD Bottle	Depth	CTD Bottle	Depth
24	Surface		Surface
17	55		50
13	98	4	100
3	150	3	132
2	193	2	200
1	300	1	300

13th October 2008

CTD_021		14th October 2008 CTD_024	
CTD Bottle	Depth	CTD Bottle	Depth
22	Surface		Surface
17	48		55
10	100		98
5	130		140
2	200		193
1	300		300

15th October 2008

CTD_027	
CTD Bottle	Depth
	Surface
	49
	100
	120
	200
	300

Appendix 4: Optics Stations information:

Date	Station	Cast id	Fltord	FRRF	Lat	Lon	Year	Julian	Eptoms	zenith
081006	1	OPT001	u	Y	49.36441	-11.51897	2008	280	271	57.176716
081007	2	OPT002	u	Y	48.86017	-16.1929	2008	281	313	56.046686
081008	3	OPT003	u	Y	45.66357	-19.58628	2008	282	263	52.739762
081011	4	OPT004	u	Y	35.31431	-28.46796	2008	285	282	42.656020
081012	5	OPT005	u	Y	32.49006	-31.7102	2008	286	285	40.156367
081013	6	OPT006	u	Y	29.66968	-34.83354	2008	287	283	37.885856
081014	7	OPT007	u	Y	26.81251	-37.89589	2008	288	291	35.842615
081015	8	OPT008	u	Y	24.73815	-40.07011	2008	289	274	34.639999
081016	9	OPT009	u	Y	21.67322	-39.59642	2008	290	273	31.915636
081017	10	OPT010	u	Y	18.78867	-37.57789	2008	291	292	28.992064
081018	11	OPT011	u	Y	16.81054	-36.20677	2008	292	271	27.133353
081019	12	OPT012	u	Y	14.09327	-34.36016	2008	293	280	24.519555
081020	13	OPT013	u	Y	10.89155	-32.20646	2008	294	288	21.504203
081021	14	OPT014	u	Y	7.66271	-30.05939	2008	295	282	18.659528
081022	15	OPT015	u	Y	5.13906	-28.39094	2008	296	263	16.715154
081023	16	OPT016	u	Y	1.82972	-26.21483	2008	297	274	14.450749
081024	17	OPT017	u	Y	-1.62899	-24.99385	2008	298	282	12.201593
081025	18	OPT018	u	Y	-6.05280	-24.97606	2008	299	285	9.003882
081026	19	OPT019	u	Y	-9.97521	-24.99948	2008	300	287	6.951113
081027	20	OPT020	u	Y	-13.99438	-24.99525	2008	301	290	6.445155
081028	21	OPT021	u	Y	-16.87545	-24.99616	2008	302	289	7.251058
081029	22	OPT022	u	Y	-20.28327	-25.00107	2008	303	278	9.110320
081030	23	OPT023	u	Y	-23.93448	-24.99943	2008	304	276	11.706650
081031	24	OPT024	u	Y	-26.55715	-24.9979	2008	305	263	13.683709
081102	25	OPT025	u	Y	-32.17939	-29.82551	2008	307	304	17.273839
081103	26	OPT026	u	Y	-34.55314	-32.98041	2008	308	266	19.297058
081104	27	OPT027	u	Y	-36.17316	-35.05416	2008	309	313	20.797585
081105	28	OPT028	u	Y	-38.76446	-38.46238	2008	310	328	23.635930
081106	29	OPT029	u	Y	-41.4747	-42.1439	2008	311	323	26.853673
081107	30	OPT030	u	Y	-43.9457	-45.64832	2008	312	329	29.915420
081108	31	OPT031	u	Y	-46.89153	-49.52857	2008	313	305	33.564239

Appendix 5: ARGO floats and Irridium drifter buoy deployment positions

Deployed for the Met Office, Exeter, UK.
This is the Bridge Science log with details of the launches.

STATION	DATE	POSITION	TIME (LOCAL)	COMMENTS
Buoy Deployment	30/10/08	23°58.7'S 025°00'W	FLOAT [1]	Number: 300034012727390
		23°59.3'S 025°00'W	ARGO [1]	Number 1409
Buoy Deployment	31/10/08	26°33.4'S 025°00'W	ARGO [2]	Number: 3910
		26°35.8'S 024°59'W	FLOAT [2]	Number: 300034012721390
Buoy Deployment	01/11/08	29°37.9'S 026°57.5'W	ARGO [3]	Number: 3912
		26°35.8'S 024°57.5'W	FLOAT [3]	Number: 300034012540450
Buoy Deployment	02/11/08	32°10.8'S 029°50.5W	ARGO [4]	Number: 3911
		32°11.0'S 029°50.5'W	FLOAT [4]	Number: 300034012541450
Buoy Deployment	05/11/08	38°45.2'S 038°26.9'W	FLOAT [5]	Number: 300034012542840
Buoy Deployment	06/11/08	41°28.8'S 042°08.1'W	ARGO [5]	Number: 3854
		41°28.9'S 042°08.2'W	FLOAT [6]	Number: 300034012543440
Buoy Deployment	07/11/08	43°57.3'S 045°38.6'W	FLOAT [7]	Number: 300034012548440