RRS Discovery Cruise Report:

Cruise D301B and D302

Indian Ocean,
20 March – 11 April 2006

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Chief Scientists

NOCS cruise report no.12

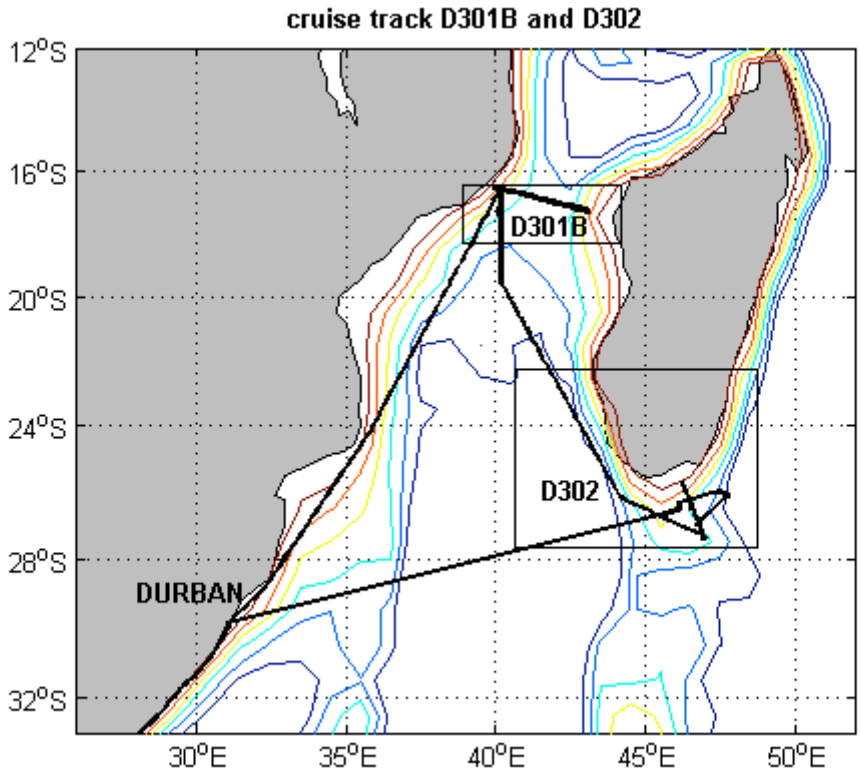

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Table of contents

The first part of the research reported here (D301B) is part of the Dutch Long-term Ocean Climate Observations (LOCO) program. LOCO is funded by the Netherlands Organisation for Scientific Research (NWO)

The second part (D302) was supported by the UK's Natural Environment Research Council through it's core strategic programme 'Ocean Variability and Climate'.

Abstract

Discovery cruises D301B and D392 were a joint expedition between NIOZ and NOC to study the waters flowing to the west and south of Madagascar. The principal aim of the Dutch component (D301B) was to recover and redeploy moorings from the narrows of the Mozambique Channel at 17˚S. These moorings contained current meters, ADCPs and sediment traps, and were accompanied by a high-resolution CTD survey and sea-bed samples taken with the multi-corer. The programme for the UK part (D302) was to recover four moorings from the south of Madagascar, and deploy some drifters. A series of CTDs were run along the main mooring line, and also 3 CTDs were placed in an eddy serendipitously lying in the route between the Dutch and UK mooring sites. Water samples from both D301B and D3002 were analysed for oxygen concentration and nutrient content.

Standard underway measurements (temperature, salinity, fluorescence and ADCP) were taken throughout the cruise. These were augmented by samples taken for biological analysis. Two hourly samples were taken separately for i) fixing and later microscopic analysis, and ii) filtering for HPLC analysis of pigments. A robot sampler was used to take small samples every 20 minutes for picoplankton studies using a flow cytometer. Experiments in the Mozambique Channel looked at the dissolution rate of silica i) through long-term deployment of incubation cages, and ii) by looking at diatom decomposition rates through filtration of large volumes from surface and bottom of CTD cats.

Keywords: Mozambique Channel, Southwest Indian Ocean, CTDs, ADCP, moorings, sediment traps, multi-corer, drifters, flow cytometry, filtered samples.

1 Cruise Narrative

1.1 Highlights

a: RV Discovery cruise D301B/D302 in the Indian Ocean (Mozambique Channel and South of Madagascar)

b: Expedition Designation (EXPOCODE): 64D301B and 64D302

c: Chief Scientist: Dr. ir. Herman Ridderinkhof[1] (D301B) and Dr. Graham Quartly[2] (D302)

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d: Ship: RRS Discovery Call Sign: GLNE
length 90 m.
beam 14.2 m
draft 5 m
maximum speed 13 knots

e: Ports of Call: Durban (South Africa) to Durban (South Africa)

f: Cruise dates: March 20, 2006 to April 11, 2006

1.2 Cruise Summary Information

Summary

On Monday 20 March, 16.00 pm, RRS Discovery left the harbor of Durban, South Africa. In Durban the Dutch part of the scientific crew joined the vessel that had left Cape Town on March 16. In Cape Town the UK part of the scientific crew had joined the vessel. First, the Discovery headed for the Mozambique Channel to recover and redeploy moorings, perform hydrographic observations and geochemical sampling, and to obtain cores from the seafloor using a multi core at the narrowest section of the Mozambique Channel. Compared to the original schedule, the cruise started about one month later, due to delays during the dry-docking period in Cape Town. Transit to the western (Mozambique) side of the section took about 4 days.

On Friday 24 March in the early afternoon we arrived at the section. The first mooring, LMC4, was released and recovered successfully. During the evening and night a multi-core station and 3 CTD stations were occupied, all on the western side of the channel section.

On Saturday 25 March three moorings were recovered successfully between 07.00 am and 16.00 pm (local time), followed by 1 multi-core and 2 CTD stations during the evening and night. On Sunday 26 March it appeared that mooring LMC6 did not come to the surface, despite contact being made with both releases, including the release of both instruments. After waiting and repeating the release procedure for an hour, a few hours were spent with surveying around the mooring location to determine the location of the releases on the seafloor as accurately as possible. Early afternoon the program was continued with a CTD station at the mooring location, followed by the successful recovery of mooring LMC7. Sunday evening and night 1 multi-core and 3 CTD – stations were occupied. The last two moorings, LMC8 and LMC9, were recovered successfully during daytime on Monday 27 March and were followed by 2 multi-core and 3 CTD- stations during the evening and night.

On Tuesday 28 March the redeployment of the moorings started with the deployment of moorings LMC9, LMC8 and LMC7, all on the eastern side of the channel section. This was followed by 2 CTD stations, one of them to calibrate the Seacat sensors from the moorings (to a depth of 1000 m), and 2 multi-core stations. Wednesday 29 March was used for dragging the (old) mooring LMC6. First trial was done with some 8 km of old mooring wire that was encircled twice with a radius of 0.2 nm around the location of the releases. This cable broke after some 5 km wire had been paid outn. Most presumably the dragging line had caught the mooring but was too weak (breaking strength about 2000 kg) to pull it to the surface. Then 2 trials with a much thicker and stronger cable were carried out. Although the releases had been displaced over the seafloor, both trials were not succesfull. Moreover the code sent out by the releases made clear that the releases were lying horizontally on the seabed. We concluded that the buoyancy must have been damaged by which the entire mooring dropped to the seafloor.

During our dragging trials this mooring cable was caught by the cable, but, most presumably, broke by the contact with the rough dragging wire.

On Thursday 30 March work was continued with the deployment of a new mooring at the location of LMC6, followed by the deployment of LMC5A and the trap mooring, all during daytime. During the evening and night the 2 last CTD-stations were occupied before the D301B part of the cruise was finished with the deployment of LMC5 and LMC4 on Friday 31 March. At 11.00 am the Discovery headed to the south to start with the D302 part of the cruise. Late afternoon some 4-5 hours of delay were caused by a transmitting ARGOS beacon that lay in a container of the afterdeck. First it was thought that this beacon came from the old mooring, LMC6, and the Discovery immediately sailed northwards. After a few hours we discovered that the signal was coming from a beacon that was on board. Then, immediately, the Discovery took the original southward cruise again

During transit to the area south-east of Madagascar, the Discovery steamed through the center of a large-scake feature that was present in the satellite-chlorophyll data. XBT's were launched on Sunday 2 April at regular distances, from just outside to the center of this feature. From the center towards the south-east side of this feature 3 CTD stations and a few XBT stations were occupied. After this survey, that continued till Monday 3 April, early morning, the Discovery steamed to the most south-eastern (and deepest) mooring.

On Tuesday 4 April work started nearby the MADEX (MADagascar Experiment) moorings. One CTD stations and 2 XBT stations were done before the first MADEX mooring was recovered successfully late afternoon. During the following evening and night the sea conditions were too rough to do any scientific work. Therefore it was decided first to steam to the location closest to the coast where a CTD station could be occupied in the early morning of Wednesday 5 April, followed by 2 other CTD stations and 1 XBT stations before the northernmost mooring was successfully recovered in the early afternoon. Another 4 CTD stations were done while steaming southwards to the last mooring on this sections. This mooring was recovered successfully on 6 April, early in the morning. The section was completed with 2 more CTD- and 2 more XBT stations during daytime. Night time was used for transit to the last mooring location, at some 90 nm to the east of the section. After arrival early on 7 April, first a CTD stations was occupied before the last mooring was recovered successfully in the morning. Then the Discovery sailed about 20 nm westward to deploy 4 Pop-up Ocean Drifters (POD's) early in the afternoon. Before sailing straight to Durban, some crossings of the East Madagascar Current were obtained in order to estimate its strength with the Vessel Mounted ADCP. On April 8 all scientific work, apart from some underway measurements was finished and RRS Discovery set course to Durban where the vessel arrived on Tuesday 11 April 2006.

Cruise Track

The cruise was carried out from Durban, South Africa to Durban. The main work area for the D301 part was at the narrowest section of the Mozambique Channel where hydrographic sections were performed, moorings were recovered, serviced and redeployed, and cores (multi-coring) were obtained from the seafloor. The D302 part consisted of a short survey (XBT's and 3 CTD stations) of a large scale feature present in the southern part of Mozambique Channel, and of the recovery of moorings that had been deployed about 14 months earlier to the south-east of Madagascar. This part included the occupation of a CTD section near to and along the moorings and the deployment of 4 Pop-up Ocean Drifters (POD's)..

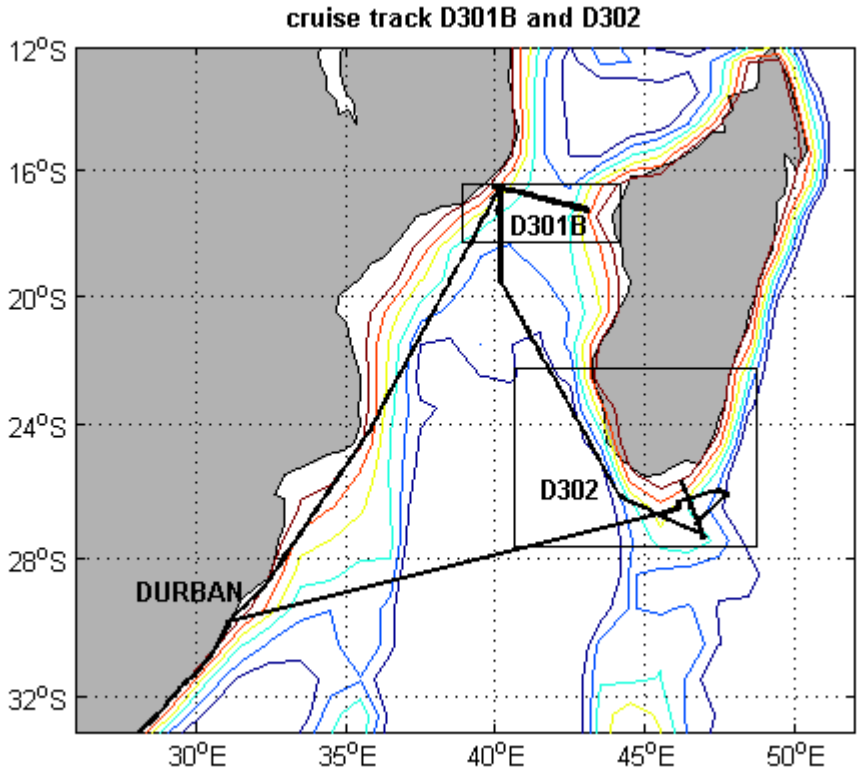

Figure 1.Cruise track of RRS Discovery cruise D301B-D302

Hydrographic Stations

D301B

A total of 16 CTD casts was recorded, including one cast to 1000 m depth for calibrations of Seacat sensors. On all of these casts, except for the test cast, water samples were taken for the determinations of nutrients, and, less frequently, salinity and dissolved oxygen (for calibration purpose only). A lowered Acoustic Doppler Current Profiler (LADCP) was attached to the CTD frame to measure vertical profiles of the current speed and direction. The positions of the hydrographic stations along the mooring sections are indicated in figure 2.

At the hydrographic stations the SBE9/11+ CTD was lowered with a speed of about 1 m/s. During the calibration cast the CTD was stopped every 100 m for a period of about 2 minutes to obtain stable temperature and conductivity measurements.

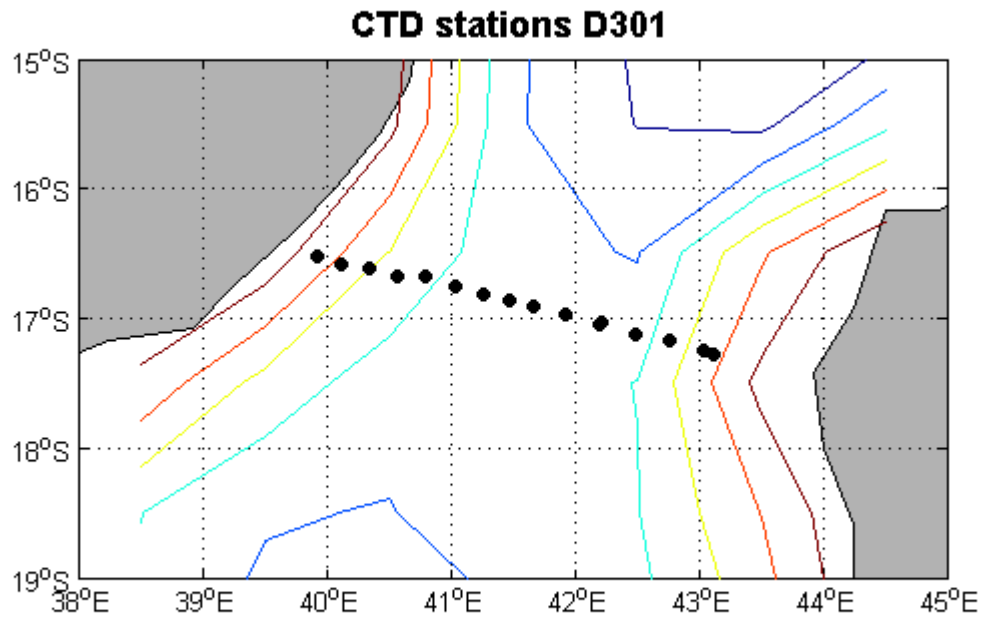

Figure 2. Distribution of hydrographic stations during the D301B part of the cruise. The isobaths at 200, 500, 1000, 2000 and 3000 m are indicated.

D302

A total of 13 CTD casts was recorded, with a set-up of the CTD equal to the D301B part of the cruise. 3 CTD stations were done in the Mozambique Channel, on one side of a large scale feature visible in satellite-chlorophyll images. To the south of Madagascar, one section with 9 stations was occupied along the section where 3 current meter moorings had been deployed. In addition one deep CTD station was occupied just before the profiling mooring at some 80 nm to the east of this section, was recovered.

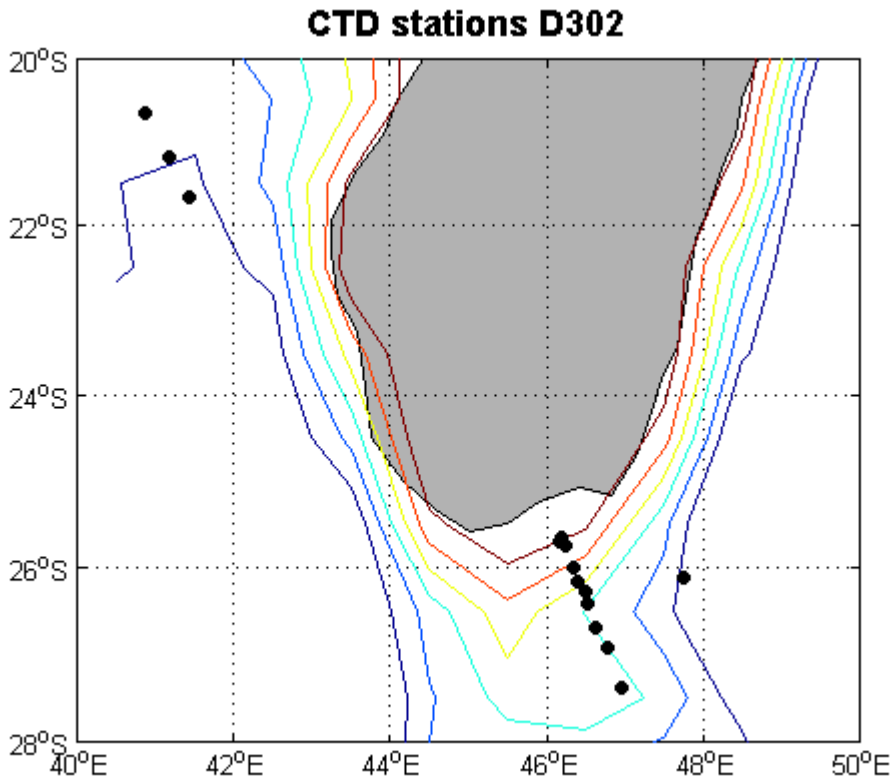

Figure 3. Distribution of hydrographic stations during the D302 part of the cruise. The isobaths at 200, 500, 1000, 2000 and 3000 m are indicated.

Hydrographic Sampling

During the up-cast of each CTD/rosette station (both during D301B and D302) up to 24 water samples were taken at regular depth intervals. The samples were analysed for nutrients and, on some stations, for oxygen to calibrate the oxygen sensor. For calibration purposes also regularly, but less frequent, samples were analysed for salinity. Bottom water samples were taken from each cast for shore-based analysis of their oxygen and hydrogen isotope composition. The vertical distribution of the sampling locations is given in table 1.

Depth (m)	Samples
Bottom	Oxygen, nutrients
2500	Salinity, oxygen, nutrients
2000	Oxygen, nutrients
1500	Oxygen, nutrients
1250	Oxygen, nutrients
1000	Oxygen, nutrients
900	Oxygen, nutrients
800	Oxygen, nutrients
700	Oxygen, nutrients
600	Oxygen, nutrients
500	Oxygen, nutrients
400	Oxygen, nutrients
300	Oxygen, nutrients
200	Oxygen, nutrients
150	Oxygen, nutrients
100	Oxygen, nutrients
10	Oxygen, nutrients
Fluorescence max	Oxygen, nutrients

Table 1. Depths at which bottle samples were collected

Moorings

D301B

The major goal of the D301B part of the cruise was the recovery, servicing and redeployment of long-term moorings at the narrowest part of the Mozambique Channel, more or less evenly distributed over the entire section. These moorings are deployed for a period of 4.5- 5 years, staring in November 2003. Each 1.5 years these sub-surface moorings are serviced. 7 moorings are equipped with ADCP's, current meters and T-S sensors. In addition, one mooring with 2 sediment traps, 2 current meters, one T-S sensor and a turbidity sensor (OBS) was deployed. The position of the moorings and the location and type of instruments in the cross-section is shown in figure 4. The measuring interval of the physical instruments ranges from 6 minutes (T-S sensors), 20 minutes (current meters, OBS) to 30 minutes (ADCP's). The cups in the sediment traps collect discrete samples of the settling particle flux over 24 intervals of 23 days. These moorings are scheduled to be recovered and redeployed in the austral summer of 2007-2008.

Detailed information on the moorings is given in the list in appendix B.

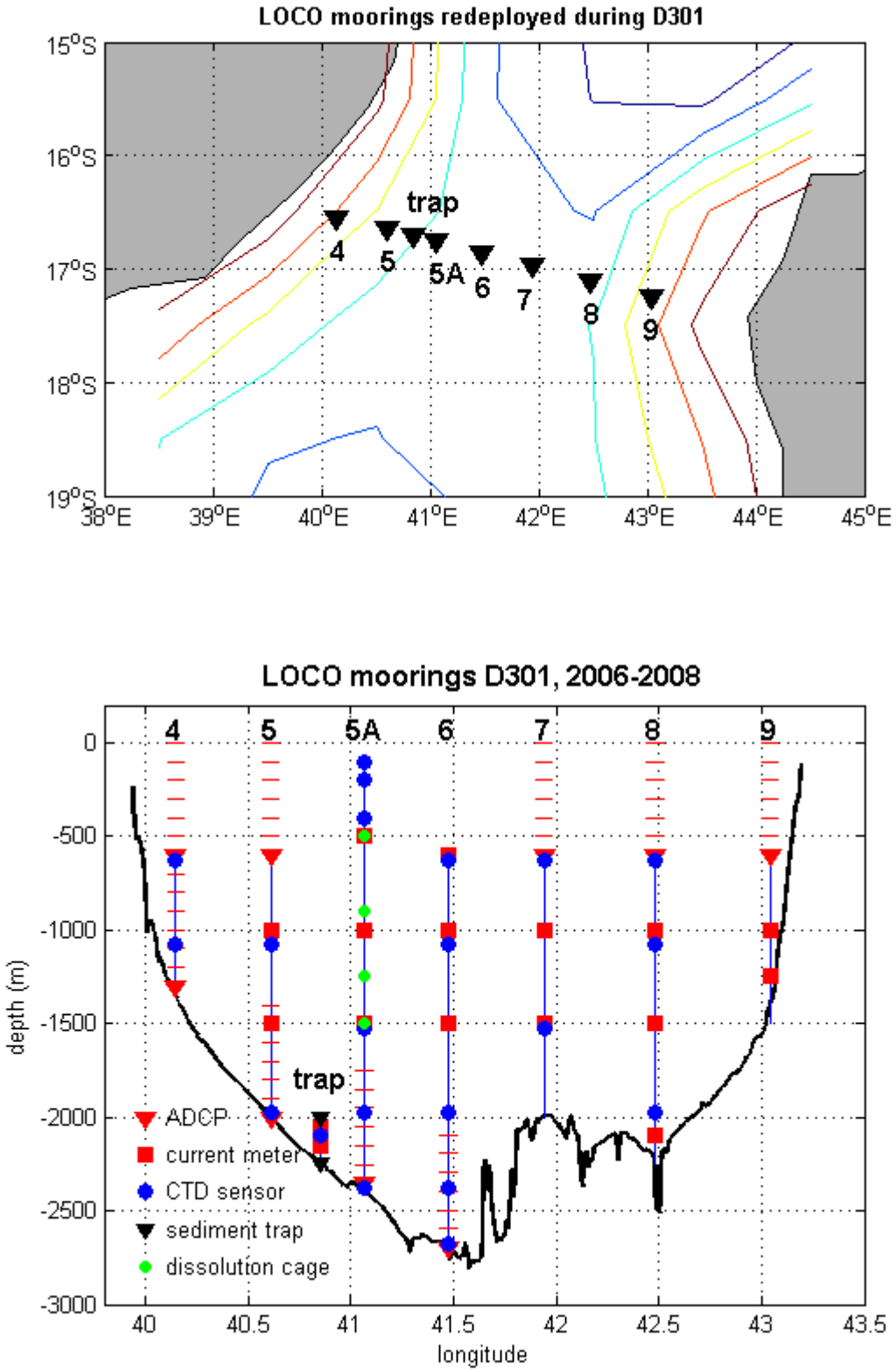

Figure 4. Position of long-term moorings in Mozambique Channel (top) and vertical distribution of the instruments (bottom) for the period 2006-2008.

D302

The location of the MADEX moorings that were recovered during the D302 part of the cruise are shown in Figure 5.

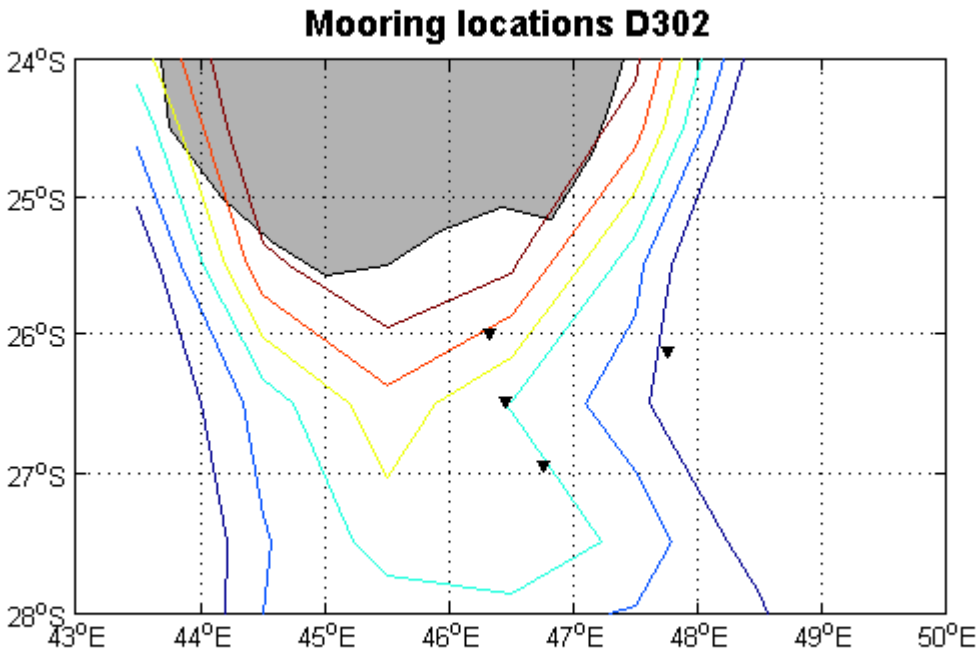

Figure 5. Position of the MADEX moorings that were recovered during the D302 part of the cruise.

These four moorings were deployed SE of Madagascar in February 2005 (see MadEx Mooring Array paper by I Waddington et al) as part of the MadEx D288 cruise. These were all recovered during cruise D302. The figure below shows the layout and instrumentation on the moorings; the details of each recovery are listed separately. All current meters and ADCPs worked successfully for the full time of the deployment, with the exception of one set of temperature-conductivity records on MadEx#1, and the McLane Moored Profiler, which ceased working after only 2 months.

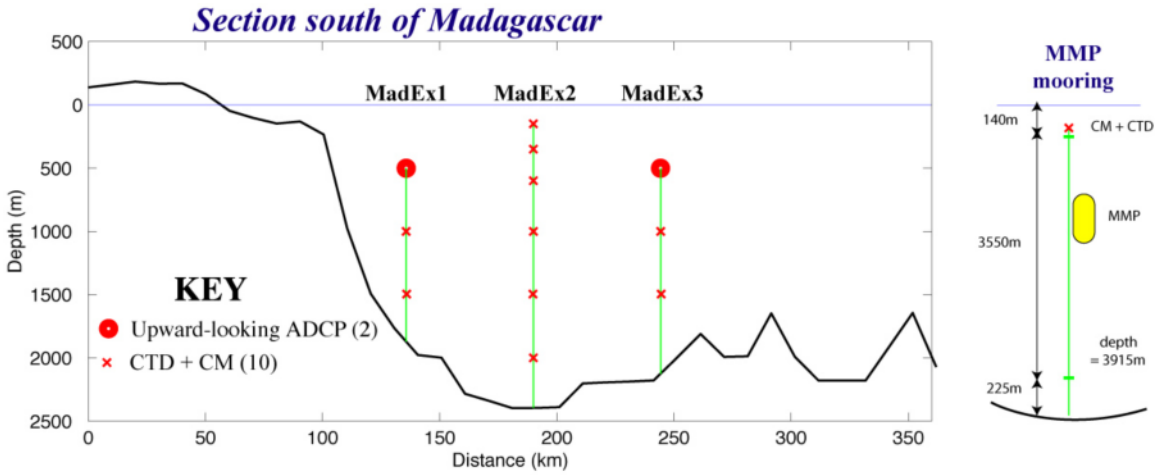

Figure 6.:Schematic of layout of moorings. Note MMP was positioned 150 km to the east (upstream) of the main mooring array.

MadEx#3 — Recovery (UKORS mooring no: 2005/06)

MadEx#3, the most southerly mooring, was recovered first. It comprised of an SMM500 Argos beacon for emergency location, an RDI Long Ranger 75 kHz ADCP, two Aanderaa self-recording current meters, and an Oceano acoustic release for re-location and recovery. The deck unit employed for all the recoveries was an IXsea Oceano TT801 (s/n: 013) patched into the PES fish single element transducer.

Recovery was on 4th April 2006, from 12:57 until 15:20 GMT. The conditions were marginal with a 5 or 6 metre swell. Unfortunately, the mooring had surfaced across the swell making the ship's approach for recovery difficult. It took the ship over an hour of manoeuvring to successfully get alongside the surface buoy and grapple the recovery line. It had also proved difficult to spot and although fitted with an Argos beacon, this had not helped matters significantly as the transmitter was underwater. The chosen position for the beacon therefore requires revising in future to allow for line drag.

MadEx#1 Recovery (UKORS mooring no: 2005/03)

This mooring was instrumented similarly to MadEx#3, but as it was in shallower water, it was shorter.

Recovery was on 5th April 2006, from 10:49 until 14:32 GMT. The syntactic float had entangled itself in the mooring line, which proved hazardous to bring on deck. As the buoy was lowered onto the deck the mooring line suddenly pulled itself out dropping the buoy without warning. All safety precautions were being followed, however, and no-one was hurt. The buoyancy package further along the line also came on deck tangled with the current meter. The line below was stoppered off and then the buoyancy and instrument untangled.

Temperature and conductivity records for one sensor (that at 1500m) were invalid, as incorrect calibration ranges had been setup.

MadEx#2 Recovery (UKORS mooring no: 2005/05)

MadEx#2 was instrumented with three conventional mechanical rotor type current meters (RCM 7's and 8) and three RCM11, Doppler type current meters. Also included were an Argos beacon for emergency location and an AR861 acoustic release for recovery and acoustic location.

Recovery was on 6th April 2006, from 05:18 until 10:06 GMT. Initially the steel sphere could not be located visually but the attached Argos beacon (an SMM500) was tracked using the Gonio receiver, eventually leading the ship to the drifting mooring. The recovery line that should have been attached to the sphere was missing, making it difficult to grapple. This was achieved on the ship's second pass and recovery begun.

MadEx MMP Recovery (UKORS mooring no: 2005/04)

The final mooring to be recovered was instrumented with an IOS-type Argos transmitter for emergency location, a single RCM11 Doppler current meter, a McLane moored profiler (MMP), and an AR861 for recovery and acoustic re-location.

Recovery: 7th April 2006, from 06:18 until 08:19 GMT. The recovery line was grappled at 06.45 and recovery proceeded smoothly to begin with. As the end of the profiler line was reached, it became apparent that the lower buoyancy pack was tangled with the bottom stop. As this was brought on deck, the MMP was found hanging beneath the buoyancy in a bight of wire. It was also noticed that the ACM sting was missing, its connecting wire hanging freely. The bight that the MMP was ensnared in was brought onboard with a lifting strop and craned gently to the deck where the profiler was disconnected from the line and taken into a lab space. The remaining mooring line to the AR861 was recovered, stops having to be made from time to time to remove long lengths of braided monofilament line which had wrapped themselves in great knots around it. This was the most likely cause of the damage to the MMP.

XBT stations

A number of XBTs (expendable bathythermographs) were used during the cruise to provide a quick fill in of gaps in temperature profiles from CTD stations. (Note, the XBTs do not provide conductivity (salinity) data, and do not record all the way to the ocean bottom.) The three types we had were T5 (produced by Sippican, to be deployed at 6 knots, and recording to 1830m), T7 (Spartan, 15 knots, 760m) and T10 (Spartan, 12 knots, 200m). We did not find any use for the shallow T10s.

All XBTs were launched from the stern of the boat, with two people present — one completing the launch, the other handling radio communications. Data were logged on a standalone PC in the Plot room. Files were then converted from RDF to EDF (extended data format, ASCII) and transferred via floppy disk to the ship's computer network.

A total of 21 XBT stations were occupied (see list in Excel spreadsheet); there was one failure, for which a replacement was immediately used. Two of the XBTs (one T5 and one T7)

were coincident with CTD stations for subsequent comparison of temperature profiles. The position where these XBT's have been launched is shown in figure 7.

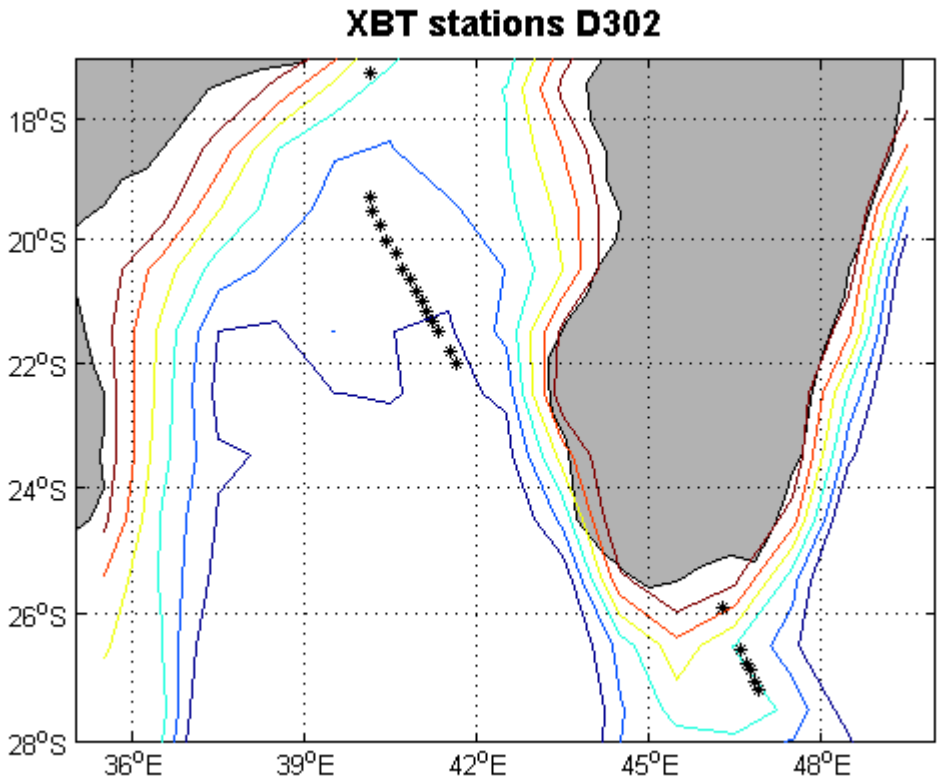

Figure 7. Positions where XBT's have been launched during the D302 part of the cruise.

Near Real-Time Satellite data

Recent satellite data were sent to the ship twice a week (Tuesday and Friday). The files, each covering the region 30˚-50˚E, 30˚-15˚S, were provided by the Remote Sensing Data Analysis Service (RSDAS) in Plymouth. Data were emailed as NetCDF files to the Principal Scientist account.

One set of files was a near real-time (NRT) altimetry product, MSLA, generated by CLS/AVISO on a $^1/_3$˚ Mercator grid. One file was a medium-resolution (0.05˚) sea surface temperature product, OSTIA, generated by the UK Met Office. The largest files (> 1MB, when compressed) contained high-resolution (~0.01˚) chlorophyll and SST data on a Mercator grid. Chlorophyll fields were typically 4-day composites from MERIS (on Envisat) and/or MODIS (on Aqua), and the SST data were a 7-day composite from MODIS.

The provision of data (as opposed to images) was very useful, in that it allowed those on ship to focus in on an area, adjust colour scales to highlight features, and add other information, such as the ship's track (see figure 8).

There were difficulties in receiving the data prior to the start of the cruise — it is believed that satellite transmission of emails was corrupted by radar tower and/or line of cranes close to

the ship in Cape Town. There was only one problem in transmission of data after we had left Cape Town.

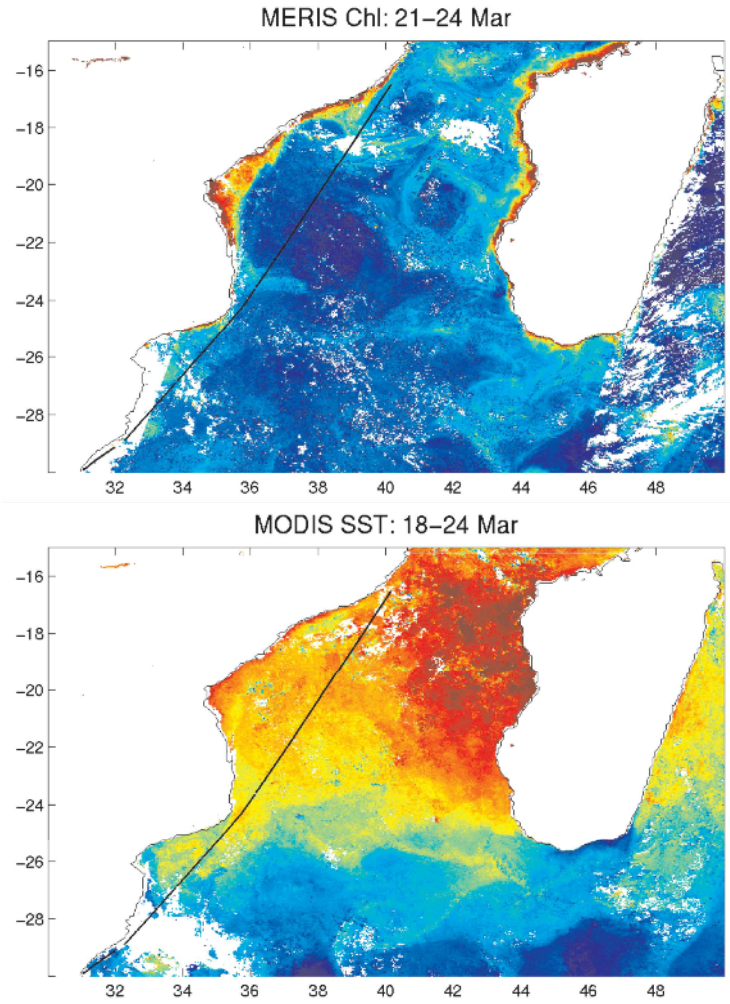

Figure 8. Plots of chlorophyll and SST data received during the cruise, with ship track to 25th Mar overlaid.

Pop-up Ocean Drifters (PODs)

This cruise provided the trial for the Mk II Pop-up Ocean Drifters (PODs). The position where these PODs have been deployed is shown in figure 9.

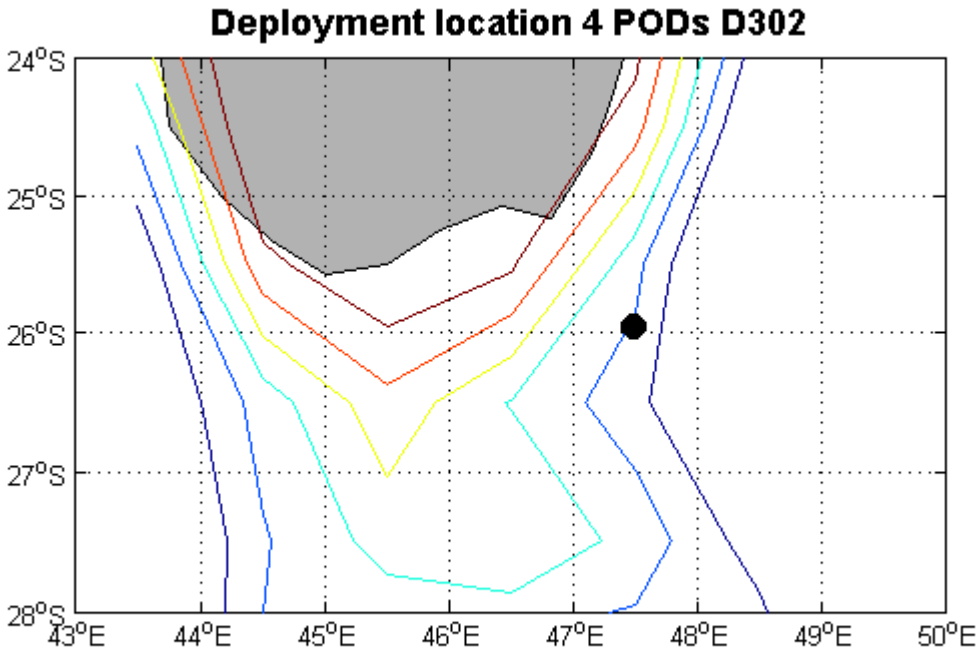

Figure 9. Positions where PODs have been launched during the D302 part of the cruise.

The surface units were provided by *Oceanetic* of Sydney (Canada), built according to our specification — light activation, GPS fixes every 2 hours to be assembled into long messages for ARGOS transmission, and a battery life of up to 18 months. The 3m-long lightweight drogues were constructed by *Comfort Afloat* of Portsmouth (UK), and the timers were developed in-house at NOC. The various components, including rope and chain, were brought together on the ship in Cape Town. Whilst in harbour, surface floats were weighed in air and then when submerged with appropriate quantity of chain, to make sure the additional weight was sufficient for a measured descent when deployed. Originally a 10" glass sphere for additional buoyancy was intended to be included, but was found to be unnecessary during ballasting tests.

The buoys were of two types; a lighter, shorter duration buoy, and a long duration buoy with a larger battery capacity. The two types were of different weights; 33 kg and 37 kg respectively, weighed on board, and thus required ballasting separately. To give a hold-down force of approximately 15kg on the sea floor, the ballast weights were originally calculated to be 19kg and 23kg taking into account the extra buoyancy of the 10" glass sphere. However, during the second ballast test the burn wire of the POD bottle parted. This was attributed to: (i) the weight approaching two thirds of the burn wires maximum safe-working load, (ii) a twisting moment exerted on the link, and (iii) a point stress applied by the cable-tie link to the drogue. (No-one was injured and no instrument was lost or damaged when the burn wire parted.)

These problems were addressed in the following ways:

(i) Reduction of the ballast weight was facilitated by removal of the 10” glass sphere. Further tests showed that the remaining buoyancy was sufficient. The ballast weights could now be reduced to 14 kg and 18 kg respectively.

(ii) The twisting moment was eliminated by using a swivel below the timer.

(iii) A Tufnell ring was fabricated to fit inside the burn wire loop for added resistance to breakage by a point stress. This was further reduced by splicing a small ring of polyester line through the loop.

Sections of line that were susceptible to chafing (e.g. the splices looping through holes in the hard hat of the buoy) were reinforced with heat-shrink or plastic tubing.

The POD’s were deployed on the 7th April 2006 starting at 11:31, all deployed by 11:41 at position 25˚ 56.7’S, 47˚ 30.0’E. They were deployed buoy first, lowered by hand over the stern, finally using a slip line through the ballast chain. The ship was going ahead slow to reduce the strain on the burn wire as much as possible. The delays on the timers were 24, 55, 85, and 116 days starting from the 6th April 2006 at 17:00 approx. This gave the following dates:

64601	24 days, surfacing on 30th April 2006
64602	55 days, surfacing on 31st May 2006
64525	85 days, surfacing on 30th June 2006
64526	116 days, surfacing on 31st July 2006.

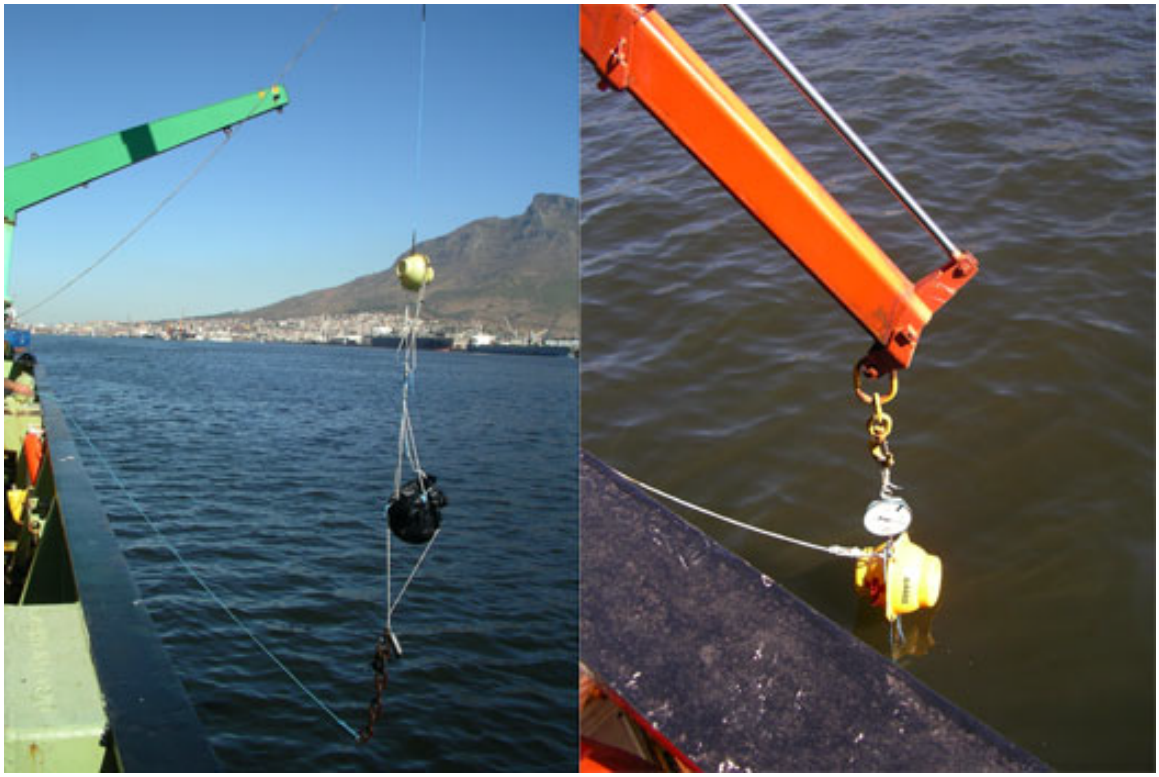

Figure 10.: Ballasting test of PODs in Cape Town harbour (left-hand picture shows furled drogue and POD timer hanging below surface float).

Unfortunately all 4 have surfaced prematurely, two on the 11th and two on the 13th April. Clearly they had reached the sea-bed (~1000 m here) and stayed fixed for several days — it is assumed that some change in current may have applied too much tension or torque to the fuse links. Thus we have not achieved a widely-staggered release, but a small group in a short time, allowing us to see how quickly pathways diverge (Figure 11)

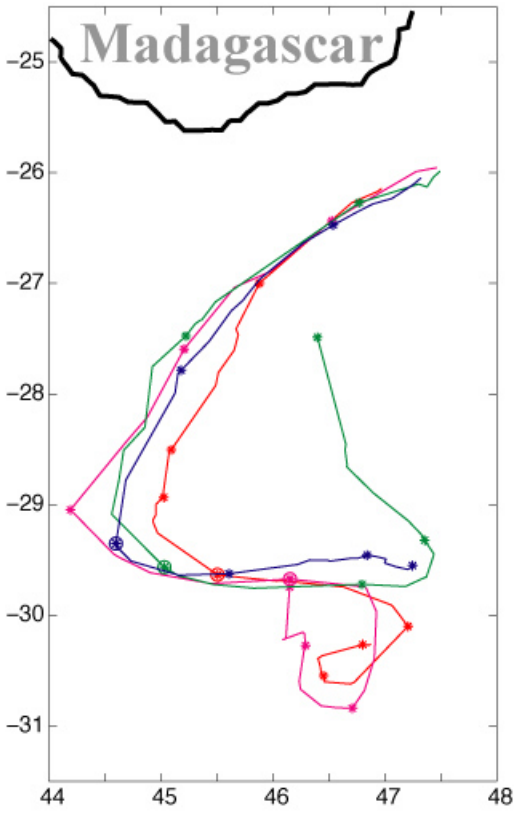

Figure 11. 22 days of trajectories of Mk II PODs (asterisks mark every 3rd day, and circles mark start of 22nd April to show the order in which PODs stream east before diverging. (Routes only shown according to ARGOS fixes; systems have GPS on board giving more frequent and more accurate positions.)

Multicore stations

On the western, Mozambican side of the section 5 Multicore stations were sampled for bottom sediments. The samples were sliced to determine the vertical distribution of pore water nutrients and total dissolved carbon in the cores and to determine the composition of the sediment across the Mozambique margin. Figure 12 shows the positions of the Multicore stations.

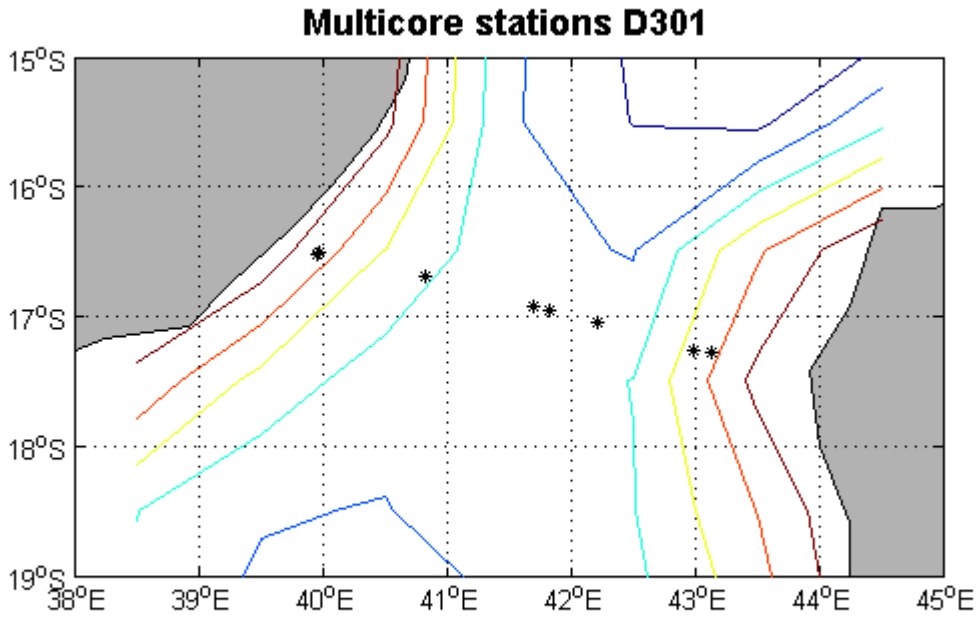

Figure 12. Position of the Multicore stations along the section.

1.3 Scientific Programme and Methods

The goal of the D301B part of the cruise was 1) to extend the dataset on long-term observations on the currents, some hydrographic properties and settling particle fluxes at the narrowest section of the Mozambique Channel from an array of moorings 2) to obtain detailed information on the hydrography along this section and 3) to further assess the sediment biogeochemistry along the section

Long-term observations with moorings (see figure 4)

To address the first goal 8 moorings were recovered, serviced and redeployed across the Mozambique channels. Of these, 7 moorings were more or less evenly distributed across the channel and these moorings were equipped with recording ADCP's, current meters and T-S sensors. The observations that started in November 2003 are planned for a period of 4-4.5 years and will be used to determine the water- and heat transport through the channel. During a previous pilot experiment in 2000-2001 it was found that the currents are dominated by southward migrating anti-cyclonic eddies which fill more or less the entire section. Therefore the original design (also based on the availability of instruments) was such that the top of 6 moorings, at 600 m below surface, was equipped with a Long Ranger ADCP. However, one mooring, LMC6, could not be recovered during the present cruise. Most presumably damage to the floating units made the mooring sink to the seafloor. Most of the instruments could be replaced with spares. However, 2 SBE's and 1 ADCP (of 2) could not be replaced. It was

decided, based on analysis of previous datasets, to leave out 2 SBE's in mooring LMC5, one at 600 m and one at 1500 m water depth. 1 ADCP at the top of mooring LMC6 was replaced by a current meter. One mooring, 5A, extends to 100 m below surface in order to have near surface observations on the (variations in) temperature and salinity. The sediment trap mooring was deployed in between moorings 5A and 6 based directly beneath the path of the Mozambique eddies. These observations will be used to determine the impact of passing eddies on settling fluxes of particles from the upper ocean and resuspension fluxes of particles from the ocean floor (see below). On some of the long moorings incubation cages have been attached to the mooring cable to study the effect of pressure variations on dissolution.

Hydrographic observations

The second goal was addressed by obtaining CTD stations with bottle samples along the entire mooring section. CTD- stations were obtained close to (distance 1 nm) the mooring locations and in between these locations. Thereby the distance between stations varied between 12-15 nm.

Biogeochemical cycling

The motivation for the third goal was that during the previous cruise in 2003, insufficient information was obtained on the biogeochemical cycling in this area, especially with regard to the composition and geochemistry of the seafloor sediment along the entire western slope of the channel. Therefore bottom samples along the continental slope were taken with a Multicore at those locations that had not been done previously, as well as a repeated sampling at the mooring location of the sediment traps for spatio-temporal variability. Moreover, results from these observations will be combined with Pistoncore samples that were taken at the same location.

1.4 Preliminary Results

Data return from the moored instruments (D301)

The recovery of all moorings and instruments went successfully, except for mooring LMC6 that could not be recovered. The data return was:

- ADCP's

9 RDI LongRangers had been deployed. Of these 2, both from mooring LMC6, sank to the seafloor and could not be recovered. All other 7 ADCP's have functioned well.

- Current meters

16 current meters had been deployed, 14 RCM11 and 2 RCM9 from Aanderaa. One current meter failed, a RCM9 deployed in mooring LMC5 at 1000 m below the surface. Two current meters, form the lost mooring LMC6, were lost.

- SBE salinity and temperature sensors.

22 SBE sensors had been deployed. All temperature and conductivity sensors that were recovered functioned well. Some pressure sensors, especially from those that had been deployed in the deeper parts, were broken. 5 SBE sensors, from the lost mooring LMC6, were lost.

- Sediment traps

Both sediment traps have functioned well. The sensor package on the bottom frame provided good data for 40% of the deployment period until the batteries ran out, whereas the OBS sensor appeared too insensitive for any useful data.

Observations from the moorings

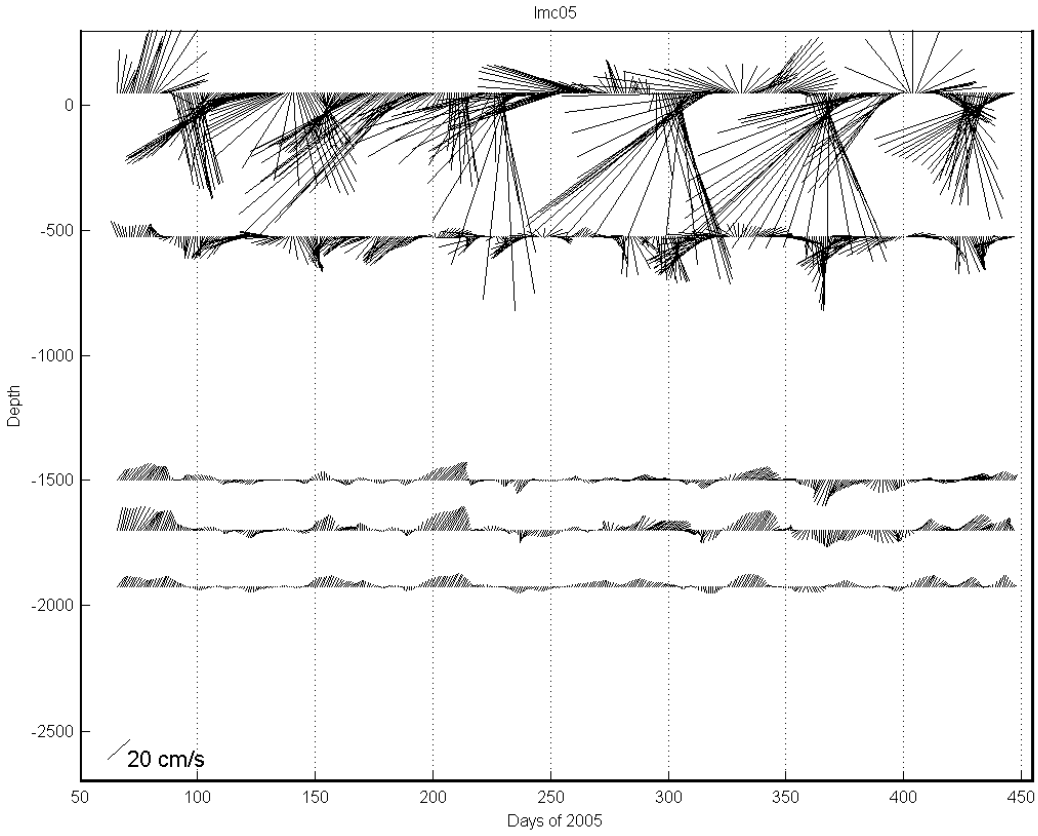

Figure 13. Low-pass filtered currents from mooring LMC5.

Figure 13 shows low-pass filtered currents from the instruments in mooring LMC5, at a water depth of 2000 m on the western side of the channel. Currents in the upper 500 m are clearly dominated by anti-clockwise rotating eddies, as was found in the pilot experiment in 2000-2001. However, there is considerable variability in the magnitude of the currents associated with the eddies. Roughly 5 eddies seem to have passed the mooring array in some 14 months. Compared to 2000-2001 the frequency of the eddy passage seems to be higher.

The near bottom currents have a stronger northward component and do not seem to be influenced by the eddies.

Calibration of the SBE temperature and salinity sensors from the moorings

Before redeploying the temperature and salinity sensors (SBE) on the moorings, these instruments were calibrated by attaching them to the CTD frame and performing a CTD cast to 1000 m below surface (because the pressure sensors seem to fail at greater depths, it was decided not to lower the CTD framer to greater depths). Every 100 m the frame was kept at the same vertical position for 2 minutes in order to have stable observations from the temperature and conductivity sensors. The sampling rate from the stand-alone SBE sensors was 5 seconds. On average 5-6 stable measurements were obtained each 100 m. These observations were compared with the observations from the recently calibrated CTD sensors on the frame and the correlation between both was determined..

Sediment trap fluxes

The recovery of two sediment traps deployed on the mooring in the Mozambique Channel at 2202 m (trap A) and 2240 m depth (trap B) respectively, show a similar pattern in sediment fluxes, except at the very start.

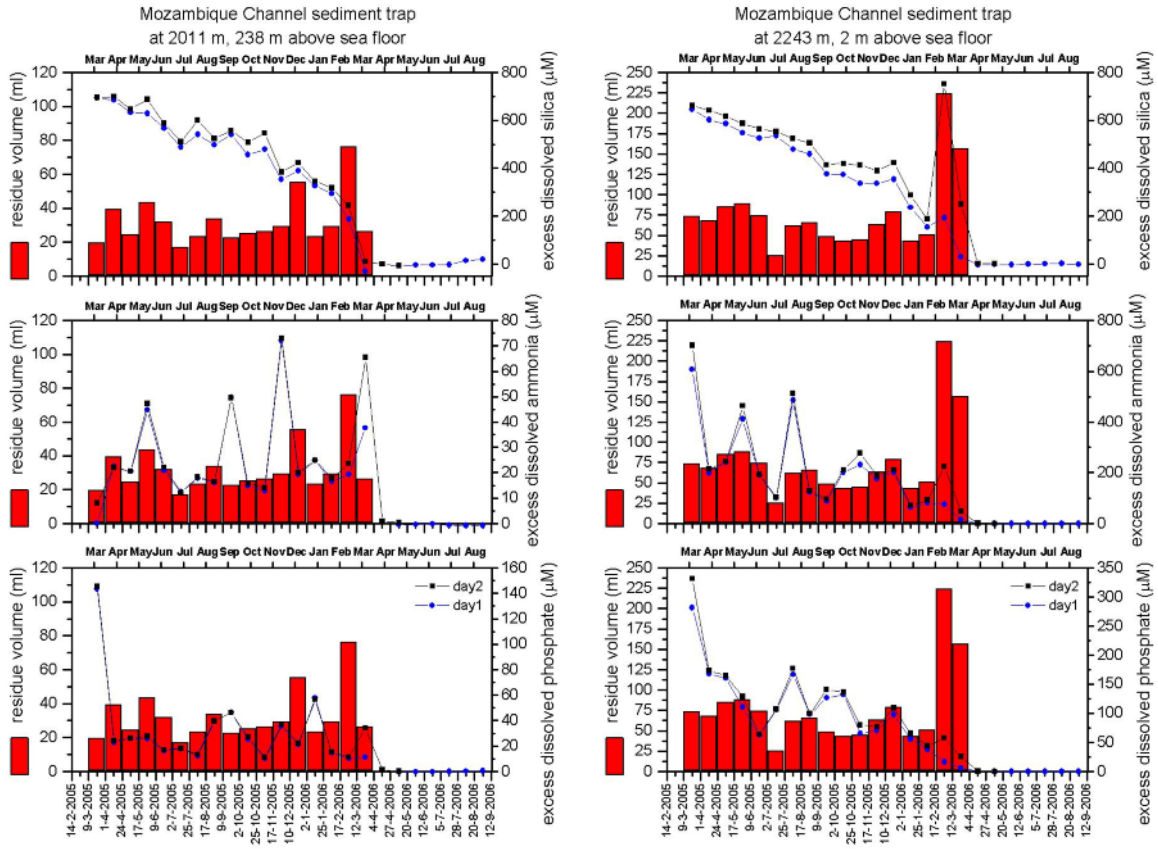

Figure 14. Residue volumes from sediment traps A and B with associated excess concentrations of dissolved silica, ammonia and phosphate sampled directly after recovery and one day later.

The tri-weekly resolved time-series from March 6, 2005 through March 25, 2006 show that the amount of accumulated material differs between trap A and trap B by approximately a factor of 2. Whereas a seasonal pattern could be discerned in the previous sediment trap time-series, no such pattern can readily be distinguished in the trap samples from 2005 – 2006. Comparatively high amounts of material are found in samples A/B-13 (December maximum), A/B-16 and A/B-17 (February/March maximum) even though the sampling period for bottles A/B-17 was aborted after 13.42 days due to early recovery. Both the December and the February/March maximum seem to correspond to an eddy having previously passed through the Mozambique Channel as well as to a currents reversal from N to S below 1000m. However, both maxima are less pronounced in trap A than in trap B.

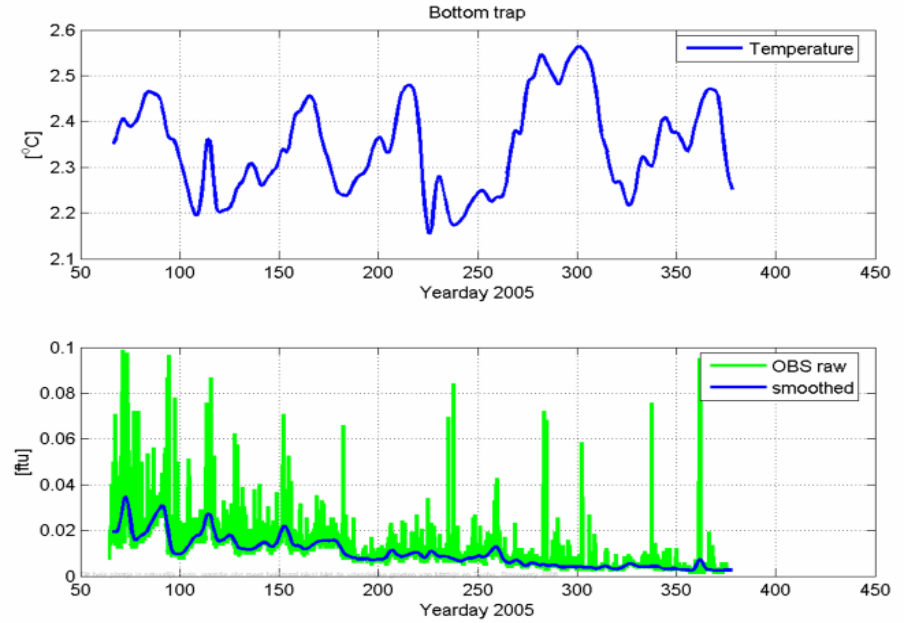

Figure 15: Temperature and OBS (a measure of turbidity) measurements from trap B showing no discernible relationships between the two.

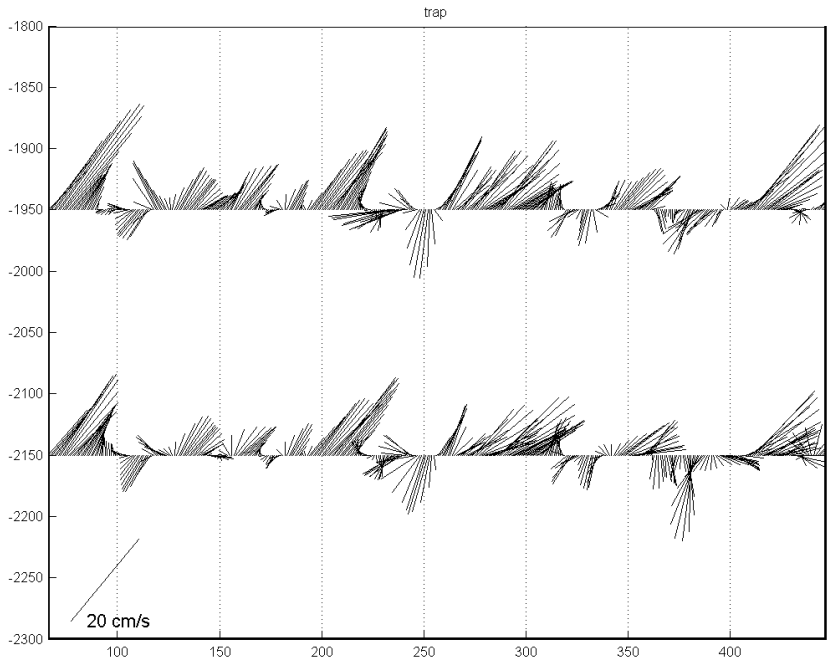

Figure 16: Comparison of current meter records from the trap mooring indicating a very good agreement between the measured bottom current velocities at both depths.

Despite a factor of 2 increase in sediment volume from the upper to the bottom trap, the dissolved silica concentrations derived from the dissolution of particulate opal (e.g. diatom and radiolarian skeletons) are slightly less in the lower sample bottles (Fig. 13). This suggests that rebound fluxes are important, i.e. silica poor aggregated matter arriving on the seafloor is re-suspended (tidally?) and recollected by the bottom trap. Also the enhanced concentrations of dissolved ammonia and phosphate in the bottom trap support this. Furthermore, dissolved silica shows a striking, almost linear decrease in concentration with the time elapsed since collection, from 700 – 750 µM in the earliest sample to about 50 – 100 µM in the last sample, testifying to the slow dissolution of opaline silica in the sample cups during the deployment year. However, the time series analyses indicate that the opaline silica is quite reactive, as concentrations increased much more rapidly than under in-situ conditions, indicating that enhanced solubility caused by the pressure release plays a significant role (see below). Neither ammonia nor phosphate shows this phenomenon in such a pronounced way. The very rapid increase in all dissolved concentrations observed in sample B16 appears to result from compaction of the particulate matter that filled the entire bottle upon recovery, thus liberating the interstitial solution.

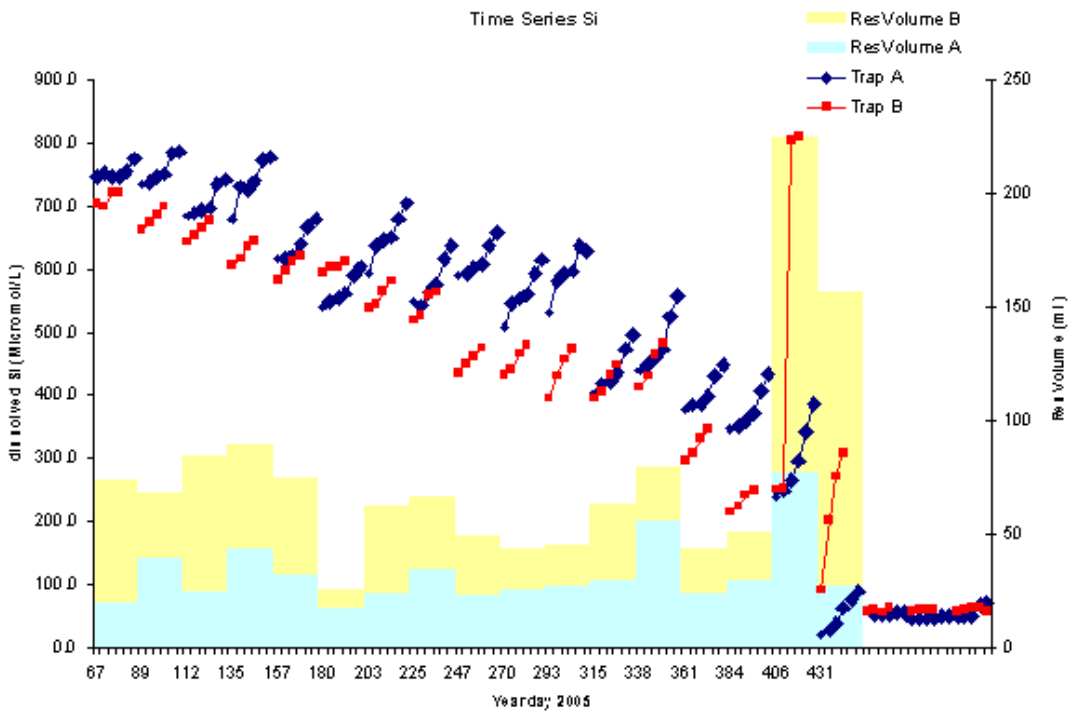

Figure 17: Time series measurements of dissolved silica in the trap solution and residue volumes for both sediment traps in 2005 – 2006.

Biogenic silica dissolution

Samples of the diatom *Thalassiosira punctigera* and of the artificial silicates *silicagel*, *aerosil 50* and *aerosil 200* had been secured to the sediment traps as batch incubations, in sea water with $HgCl_2$ and buffered with $Na_2B_4O_7 \cdot 10H_2O$. Upon sediment trap recovery, the different silicates were sampled immediately and at regular intervals afterwards to determine the pressure dependence of silica solubility. This sampling time series will be continued at home in the lab. For silicagel, incubated at 2250 (p=225 bar) and 2000 (p=200 bar) the increase of the dissolved silica concentration in solution versus time is given in figure 18.

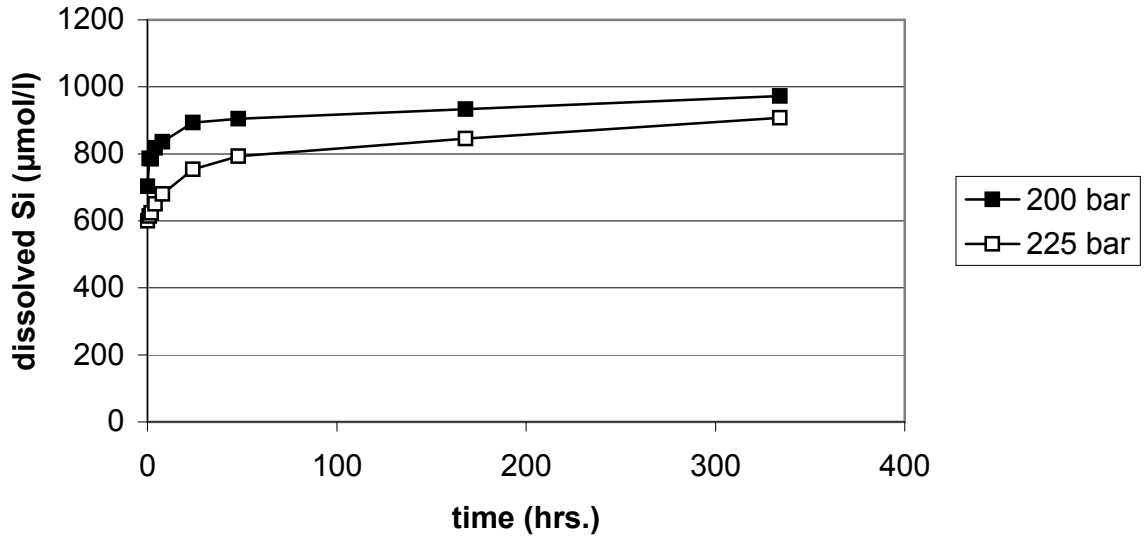

Figure 18: The rapid increase in dissolved silica concentration observed when samples were returned to atmospheric pressure.

1.5 Major Problems Encountered during the Cruise

Mooring recovery and redeployment went very smoothly and successfully, except for the recovery of mooring LMC6 as part of the D301 cruise. Most presumably this mooring has sunk to the seafloor. Both releases indicated that they were lying in a horizontal position. We guess that one of the buoyancy floats, deployed at some 1000 m below surface, has broken. When this mooring was recovered in March 2005, this float fell on the afterdeck during recovery due to a break in the mooring wire. Most presumably this has caused internal fractures in the float which, at greater depth, have led to a complete dismantling of the float, resulting in the sinking of the entire mooring.

All other activities went smoothly.

1.6 List of Cruise Participants

Scientific crew

Name	Institute	Nationality	Function/ Speciality
Herman Ridderinkhof	NIOZ	NL	Chief scientist
GeertJan Brummer	NIOZ	NL	Sediment traps, Piston coring
Erica Koning	NIOZ	NL	Multi coring
Karel Bakker	NIOZ	NL	Nutrients, oxygen
Marcel Bakker	NIOZ	NL	Moorings
Jack Schilling	NIOZ	NL	Moorings
Theo Hillebrand	NIOZ	NL	Instruments
Sander Asjes	NIOZ	NL	Electronics
Ulrike Fallet	NIOZ	NL	PhD, traps
Socratis Loucaides	University Utrecht	NL	PhD, MultiCoring
Petra van der Werf	University Utrecht	NL	PhD, instruments
Matthijs Schouten	NIOZ	NL	PostDoc,Data analyses
Tycho Huussen	NIOZ	NL	Student, instruments
Graham Quartly	NOC	UK	Physical oceanography
Ross Holland	NOC	UK	Biology
Blanca Puig-Mauriz	NOC	UK	Biology
Ronald de Souza	Instituto Nacional de Pesquisas Espaciais	Brazil	Physical Oceanography
Antonio da Silva	INAHINA	Mozambique	Observer
Jeff Benson	NOC-UKORS	UK	CTD
Paul Duncan	NOC-UKORS	UK	Computers
Darren Young	NOC-UKORS	UK	CTD
John Wynar	NOC-UKORS	UK	Mooring winch

2 Underway Measurements

A large number of atmospheric and oceanic parameters are automatically logged every 30 seconds. As well as being logged, the last 8 hours are on display on the 'SurfMet' computer, and data are also automatically sent back to NOC via the Autoflux system.

The meteorological sensors are located at the top of the foremast. Prior to departure from Cape Town, lenses of Licor radiometer were washed with fresh water, and the reservoirs for the hygrometers were topped up. This was repeated at the end of the cruise in Port Elizabeth, where it was found that one of the reservoirs was leaking.

The instrumentation measuring surface water properties is housed in the water bottle annex, enabling easy access. It is fed by water taken from an intake at 5m depth, with the flow taking ~2.5 minutes to reach the instrumentation. The various sensors are listed in the table below.

Manufacturer	Sensor	Serial no	Comments
FSI	OTM temperature	1370	HOUSING, calibration held internally in sensor
FSI	OTM temperature	1360	REMOTE, calibration held internally in sensor
WETLabs	fluorometer	WS3S-247	
WETLabs	transmissometer	CST-112R	
Vaisala	Barometer PTB100A	U1420016	
Vaisala	Temp/humidity HMP44L	U11850012	
SKYE	PAR	28558	port
SKYE	PAR	28557	stb
Kipp and Zonen	TIR CMB6	047462	port
Kipp and Zonen	TIR CMB6	047463	stb
Sensors without cal			
FSI	OCM conductvity	1376	Original manufactures calibration. Surface salinity is produced from computed PRO_TSG then corrected with wet samples.
Vaisala	Sensor collector QLI	S353014	
Vaisala	Anemometer WAA	P50421	
Vaisala	Wind vane WAV	S21214	
Rhopoint	+/- 5v		
Rhopoint	+/- 5v		

Table 2.Sensors on the SurfMet system

Monitoring was performed by visual checks every 2 hours on the real-time displays. The signals of the transmissometer and fluorimeter occasionally dropped to near zero: this was remedied by increasing

flow to remove bubbles. At the narrows of the Mozambique Channel, the temperature and conductivity records seemed highly variable — it is believed that this is genuine physical variations, rather than instrument malfunction. Samples from the underway supply were taken 3 or 4 times per day for salinometer analysis (see section 3), to provide a check on the salinity values. Underway sampling for pigments, microscopy and flow cytometry were all taken from the same 'non-toxic' supply.

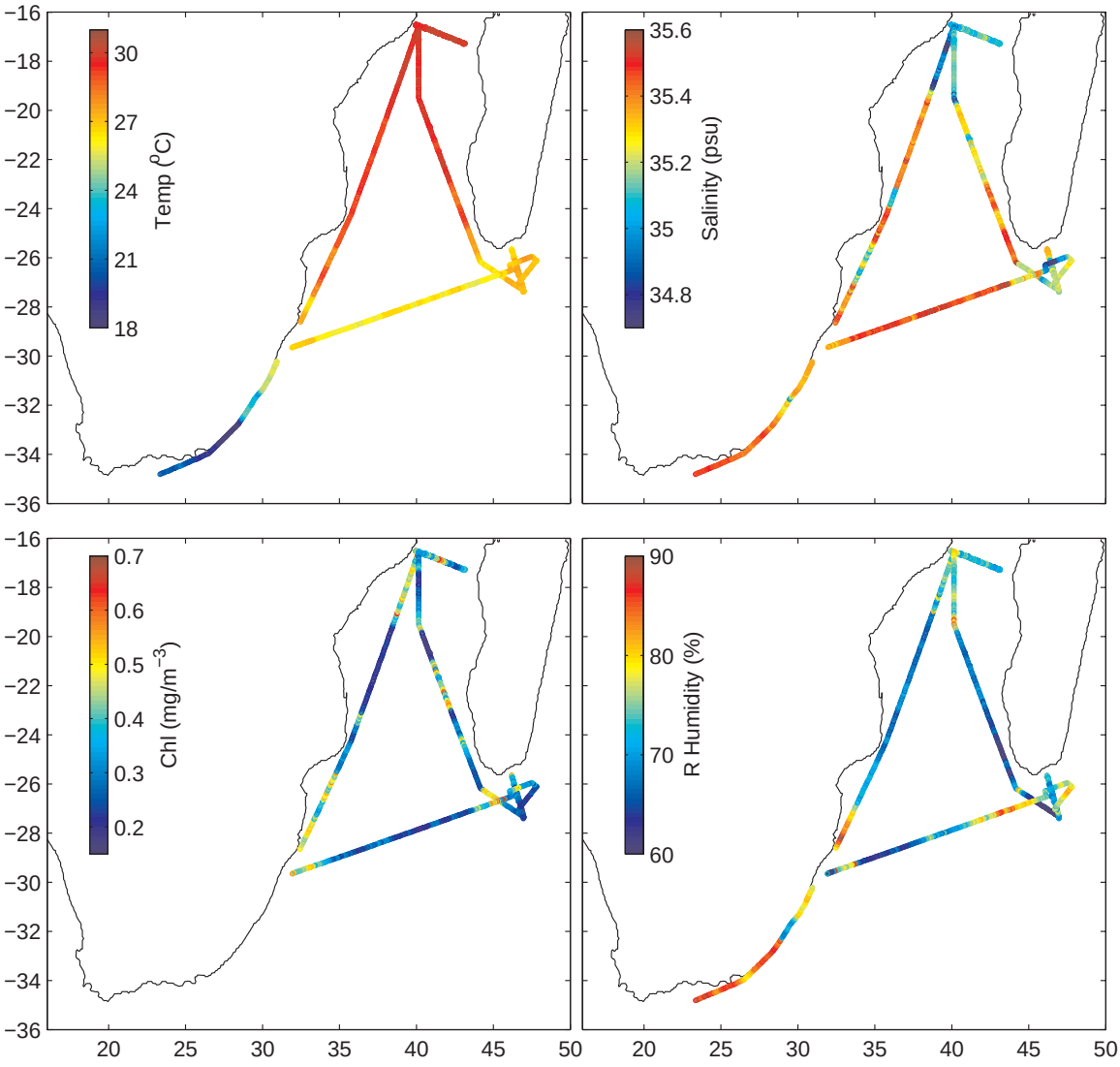

Figure 19. Plots of some of the underway surface/meteorological conditions during cruise. Note, output of fluorescence sensor (giving chlorophyll estimates) was contaminated before being cleaned at Durban port call.

Wave Height Data

Wave spectral information was also recorded via the shipborne wave recorder. These data were logged on a different computer, and are provided as a separate file to the 'surfmet' data. There were a few problems with the clock on the SBWR. It was initially 297s slow (midday on JDay 077) and finished 395s slow (midday on JDay 100). However, it also lost one hour at 02:00 GMT on Sun 25th

March (which has been removed in above summary of clock drift) — this is coincident with shift from GMT to BST (British Summer Time), and may be a correction to a clock that didn't change!

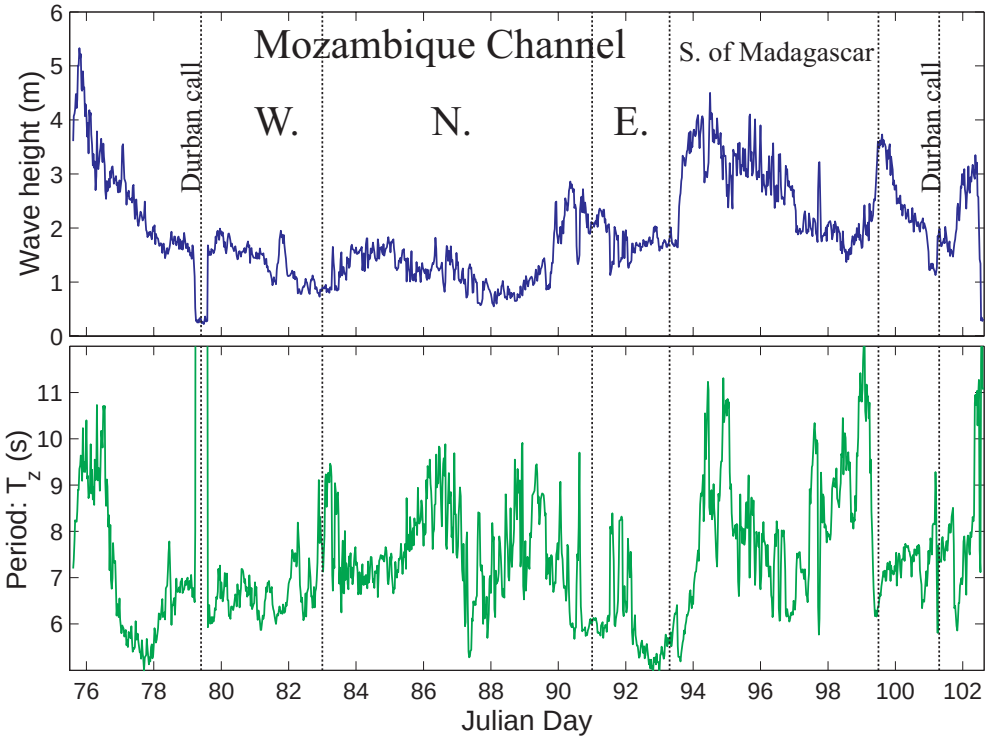

Figure 20.: Plots of wave conditions during cruise, showing long period swell dominating once we were south of Madagascar to recover the MadEx moorings.

Fast Repetition Rate Fluorimeter (FRRF)

A Chelsea Instruments FRRF was sited in the Water Bottle Annexe for the duration of the cruise, operating in bench-top mode, acquiring discrete samples every 30 seconds via the underway seawater pumping system. The instrument offers rapid, continuous, in situ measurements of the photosynthetic characteristics of the marine phytoplankton. These characteristics are measured by the fluorescence response of the phytoplankton to a series of high-frequency flashes of blue light emitted by the FRRF equipment. FRRF data have been recorded onboard since the ship's departure from Cape Town; with a total of four data files being downloaded. Measurements can be fed into models to allow the estimation of photochemical/nonphotochemical quenching, photochemical conversion efficiency, and primary production. We applied a model developed at the University of Essexwhich fits both saturation and relaxation data simultaneously (Sam Laney, personal communication).

Hyperspectral radiometers

Two TriOS radiometers were installed on the ship's bow, and downward radiation (atmospheric) and upward (sea) radiation were recorded onboard the ship since departure from Durban. The radiometers are portable and had been brought from the NOC especially for this cruise. Radiances were registered during daytime in wavelengths ranging from 304 nm to 1130 nm.

Radiation intensity is a function of the time of the day, obviously peaking at midday local time. Downward radiation is the Sun radiation transmitted, scattered, reflected and re-emitted by the atmospheric constituents. Upward radiation is the radiation reflected and emitted by sea waters and their spectral characteristics are related to their constituents. Most of the satellite sensors measuring ocean colour do that over part of the spectral ranges measured by the TriOS radiometers used here. A combination of in situ radiance data taken by the radiometers and chlorophyll concentration measurements can be used for validation of satellite data.

There were three difficulties with the instrumentation:

1) A connectivity failure in one of the radiometers resulted in no signal; this was resolved by the ship's engineers opening up the device and reconnecting the wires. Later in the cruise, there were various spikes in the data, which may possibly be related to poor contacts and/or moisture in the system.

2) A laptop was borrowed for the simple task of logging the data, but after a few weeks the PC clock started running very slow (order 10%). This effect was not linear, so regular checks had to be made on the clock error.

3) The software package would not recognise the calibration files for the sensors, so all values returned are uncalibrated and need post-processing.

Shipborne ADCP

RRS Discovery has two hull-mounted ADCP systems.

150 kHz system

The system was initially set up with 64 x 4-m depth bins, allowing ~64 pulses to be averaged in every 2-minute interval. At 13:14:30 GMT on JDay 081, the set up was changed to 88 x 4m bins to provide deeper coverage, allowing ~55 pulses per 2-minutes. Initially, the clock on the logging computer was 2490s (41.5 mins) behind GMT; this was corrected at the first port call in Durban (midday on JDay 079), and it subsequently lost another 85 secs over the length of the cruise (up to midday on JDay 100). These data were downloaded daily.

75 kHz system ('Ocean Surveyor')

This system was set up with 8m bins, allowing deeper coverage, but lower resolution than the 150 kHz system. These data were then averaged in 2-min ensembles. Clock drift was very small, with clock being 3.5s slow at midday on JDay 077 and 22s slow at midday on JDay 100. System was switched off for 3 mins at 15:21 GMT on JDay 084. Data were only downloaded from system at the end of the cruise, but the software controlling this ADCP provided a real-time display that was useful for monitoring the ship's progress through the eddy/current field.

Initial cruise track from Cape Town to Durban provides a long segment of steady course over shallow bathymetry (order 100m), which can be used for validation of ADCPs through assessment of sea bottom velocity.

3 Hydrographic measurements - Descriptions, Techniques, and Calibrations

Rosette Sampler and Sampler Bottles

A 24 position rosette sampler was used, fitted with Niskin sampler bottles. The general behaviour of the samplers was good. Only a few samples are considered to be suspect because of sampler failure. No errors in the functioning of the rosette sampler itself were detected.

Salinometer analysis

A Guildline Autosal 8400B salinometer (s/n 68426) was sited in the Stable Lab, with the bath temperature set at 27C, 2 to 3 degrees above ambient temperature. Softsal was used as the data recording program for salinity values, and results were plotted via an Excel spreadsheet: A total of 136 salinity samples were taken during the cruise, 64 for CTD analysis and 72 for TSG analysis. Periodic problems with the 20L water samplers not closing properly were indicated by salinity values greater than typical offsets of 0.003 PSU, and are duly noted on the spreadsheet.

Nutrient Measurements

From all sampler bottles attached to the CTD, samples were drawn for the determination of the nutrients silica, ammonia, nitrate and phosphate. Other samples were collected from the multicore and from some flux-experiments. The samples were collected in polyethylene sample bottles after three times rinsing. The samples were stored dark and cool at 4°C. All samples were analysed for the nutrients silicate, phosphate, nitrate and ammonium within 12 hours with an autoanalyzer based on colorimetry. The lab container was equipped with a Technicon TRAACS 800 autoanalyzer. The samples, taken from the refrigerator, were filtered over a 0.20um acrodisc filter, pored in open polyethylene vials (6ml) and put in the auto sampler-trays. A maximum of 50 samples in each run were analysed.

The different nutrients were measured colorimetrically as described by Grashoff (1983);

- Silicate reacts with ammoniummolybdate to a yellow complex, after reduction with ascorbic acid the obtained blue silica-molybdenum complex was measured at 800nm (oxalic acid was used to prevent formation of the blue phosphate-molybdenum).
- Phosphate reacts with ammoniummolybdate at pH 1.0, and potassiumantimonyltartrate was used as an inhibitor. The yellow phosphate-molybdenum complex was reduced by ascorbic acid to blue and measured at 880nm.
- Nitrate was mixed with a buffer imidazole at pH 7.5 and reduced by a copperized-cadmium coil (efficiency> 98%) to nitrite, and measured as nitrite. The reduction-efficiency of the cadmium-column was measured in each run.

• Ammonium is reacted to a coupled indophenol hypochlorite complex described by Helder and de Vries, measured at 630nm .

Calibration standards were prepared by diluting stock solutions of the different nutrients in the same nutrient depleted surface ocean water as used for the baseline water. The standards were kept dark and cool in the same refrigerator as the samples. Standards were prepared fresh every two days. Each run of the system had a correlation coefficient for the standards off at least 0.9998. The samples were measured from the surface to the bottom to get the smallest possible carry-over-effects. In every run a mixed control nutrient standard containing silicate, phosphate and nitrate in a constant and well known ratio, a so-called nutrient-cocktail, was measured, as well as control standards, sterilized in an autoclave or gamma radiation. These standards were used as a guide to check the performance of the analysis and the gain factor of the autoanalyzer channels. The reduction-efficiency of the cadmium-column in the nitrate lane was measured in each run.

The autoanalyzer determined the volumetric concentration (µMol/dm^3) at a temperature of 24-26°C.

Dissolved Inorganic Carbon

The cores of the multicore stations were sampled for DIC to be measured at home.

Samples were filtered over 0.45µm acrodisc filters and put in a glass vial (4ml) containing 10µl saturated HgCL2 as a preservative. Measurement will be done home, using a spectrophotometric-method described by Stoll and Bakker (Marine Chemistry 2001).

CTD Data Collection and Processing

A total of 30 CTD casts were completed on this cruise, 16 on D301B and 14 on D302.

Initial sensor configuration

Sea-Bird 9 plus underwater unit, s/n 09P-37898-0782
Sea-Bird 3 Premium temperature sensor, s/n 03P-2728 (Frequency 0)
Sea-Bird 4 conductivity sensor, s/n 04C-2851 (Frequency 1)
Digiquartz temperature compensated pressure sensor, s/n 94756 (Frequency 2)
Sea-Bird 3 Premium temperature sensor, s/n 03P-2729 (Frequency 3)
Sea-Bird 4 conductivity sensor, s/n 04C-2858 (Frequency 4)
Sea-Bird 43 dissolved oxygen sensor, s/n 43-0612 (V0)
Benthos PSA-916T 7Hz altimeter, s/n 1037 (V2)
Chelsea Aquatracka MKIII fluorometer, s/n 88-2960-160 (V3)
WETLabs Light Scattering sensor, s/n BBRTD-169 (V6)
Chelsea Alphatracka MKII transmissometer, s/n 04-4223-001 (V7)
Sea-Bird 11plus deck unit, s/n 11P-19817-0495

Ancillary instruments & components:

Sea-Bird 24-position Carousel, s/n 32-24680-0344
NOC/SBE 'BreakOut Box', s/n BO19106

NOC 10KHz acoustic pinger, s/n B12

Sonardyne HF Deep Marker Beacon, s/n 215303-01

RD Instruments BroadBand 150KHz ADCP, s/n 1503 (downward-looking)

NOC/RDI stainless steel BroadBand battery pack, s/n 02

RDI WorkHorse Monitor 300KHz ADCP, s/n 5414 (Master: downward-looking)

RDI WorkHorse Monitor 300KHz ADCP, s/n 1881 (Slave: upward-looking)

NOC/RDI aluminium Workhorse battery pack, s/n WH001

24 x Ocean Test Equipment ES-10L water samplers, s/n 01 through 24

CTD analysis & changes to configuration

A) The RDI BroadBand ADCP lost communications during on-deck testing prior to the first station, and was removed from the frame, along with the NOC/RDI stainless steel battery pack. Subsequent investigations revealed the power/communications cable had melted because of a short circuit. The short circuit caused the failure of four fuses on the backplane PCB within the ADCP; being unable to determine the cause of the short circuit and consultations with RDI led to not re-installing the BroadBand ADCP on the CTD frame.

B) Prior to cast D301B_04, six of the 10L OTE water samplers were removed and replaced with 20L OTE ES water samplers, in bottle firing positions 1, 2, 3, 21, 22, and 23. This was done in order to increase the volume of water available at the bottom and chlorophyll maximum sampling depths.

C) Prior to cast D302_001, the Benthos altimeter was replaced with Tritech PA-200 1Hz altimeter, s/n 6196.118171, for testing purposes only. Both the Benthos and Tritech models performed well throughout the trip, with ranges typically beginning at 70+ metres from the seabed. The Tritech would on occasion lose contact with the seabed upon approach to the bottom, usually beginning at a range of 20 metres from the seabed.

D) From the first station onwards, noise and spiking was frequent on almost every cast in either or both the Chelsea fluorometer and Chelsea transmissometer. Removing and cleaning connectors on the instruments and the BreakOut Box, replacing cables, and removing the sensors from the frame for bench testing did not reveal the cause of the noise nor solve the problem. Both instruments passed all tests whilst on-deck and in the lab, and the problem confined itself primarily to the upcast portion of the station.

E) The RDI WorkHorse Monitor ADCP's performed as expected for the duration of the cruise, with the exception of no Slave data on cast D302_012. Examination of the log file revealed no errors in the command file sent to the instrument, nor were there any errors or data problems with the corresponding Master data.

4 Flow Cytometric Analysis of Microbial Community Structure and Abundance

The purpose of the survey is to relate flow cytometry data with satellite chlorophyll and underway radiometry data to investigate relationships between ocean-colour and picoplankton community structure.

The relative abundances of populations of picophytoplankton and heterotrophic bacterioplankton were investigated and the community structure of these groups characterised flow cytometrically using a Becton Dickinson FACSort, Analytical Flow Cytometer.

Discrete groups of picophytoplankton were visualised in bivariate dotplots of sideward light scatter (conferring cell size) against red (Chlorophyll content) and Orange (Phycoerythrin content) fluorescence using Cellquest Software.

500µl of each sample was incubated in darkness at 30°C with a DNA stain (Sybr Green I; final conentration 0.01%) for at least 1 hour before analysis. The stain facilitated the visualisation and enumeration of discrete groups of non-autofluorescent heterotrophic bacterioplankton in bivariate dotplots of sideward light scatter and green fluorescence (linked to relative nucleic acid content per cell).

Yellow-Green fluorescent microspheres (0.5µm diameter) were added to each sample and subsample at a known concentration in order to provide an internal standard against which varying fluorescence per cell of different groups could be quantified. Having been added at a known concentration, the microspheres allow the quantification of cells/ml per group in each sample.

Samples were drawn regularly from the ships non-toxic seawater supply and from all CTD casts. The following pages give an overview of the sampling regimes; full details of the CTD sampling are provided in the attached spreadsheet

CTD Sampling Regime

Samples for Flow Cytometric analysis were drawn on each CTD cast except CTD D301 13, when no Niskin Bottles were fired. On many casts, multiple bottles were fired at the chlorophyll maximum. Water was analysed from all bottles between 200 metres and the depth closest to the surface. During D302 CTD casts, replicate bottles were often fired on opposing sides of the CTD rosette; this was to investigate possible extreme small-scale variation in community structure and abundance. A full list of stations and bottles analysed is in the attached spreadsheet.

Underway Sampling Regime

Samples were drawn from the ship's non-toxic seawater supply and fixed with paraformaldehyde (final concentration 1%) by a Tecan Miniprep 60 Liquid handling robot. Samples were analysed within 24 hours of being drawn.

Period (Julian Day)	Sampling interval	Comments
079 - 083	20 min	Started at 20:40 on day 079, and continued with one sample being drawn every 20 minutes as the ship steamed along a transect North from the Port of Durban, SA, along the East Coast of South Africa and Mozambique
083 - 090	40 min	Changed at 08:40 on day 083, as we began a 7-day period of moorings, corings and CTD casts along a West – East transect across the Mozambique Channel towards Northern Madagascar. The reduction in sampling was to avoid extensive repeated sampling of the same waters whilst the ship was on station for extended periods of time, and also to accommodate time for drawing and analysing samples from Niskin bottles associated with CTD casts (See below.)
090 - 091	20 min	At 09:00 on day 090, 20-minute sampling was resumed as the ship steamed SE from the end of the first set of moorings towards the location of the second set.
091 - 092	10, 40 min	This passage took the ship though a body of water identified from satellite chlorophyll data to be an eddy feature. As a likely area of increased small-scale variability in plankton abundance and community structure, sampling frequency was increased to every 10 minutes at 03.20 on day 091 and was terminated at 13:00 on day 092. During the passage across the eddy, three CTD casts were undertaken. Whilst on station for these casts, sampling frequency was decreased to once every 40 minutes. These periods were 14:20 – 16:40 (day 091) 20:10 – 22:40 (day 091) and 03:20 – 05:40 (day 092).
092 - 094	20 min	From 13:00 on day 092 to 06:40 on day 094, 20 minute sampling was resumed as the most recent satellite data indicated that the passage through the eddy feature had been completed.
094 - 097	20, 40 min	Between 06:40 on day 094 and 00:00 on day 098, a 20 minute sampling frequency was sustained except when the ship was on station for extended periods of time. During these periods, sampling frequency was decreased to 40 minutes. Work along the transect was completed on day 097 and a 20 minute sampling frequency was continued for the beginning of the return passage back to Durban, South Africa.
098 - 100	40 min	Sampling reduced to every 40 min at 00:00 on day 098, and continued until 16:00 GMT on Day 100, when we were close to Durban. The sampling rate was reduced to allow time for data

		analysis, and preparations for demobilisation.

5 Phytoplankton analysis

In addition to the flow cytometer analysis (section 4), samples were collected for three other analyses of the phytoplankton. These analyses are microscopic examination of individual organisms, HPLC analysis of pigments and identification of the isotopic rations in the Particulate Organic Matter (POM). All three analyses are to be applied to underway samples and to water collected at CTD stations. This section provides an overview of the sampling regime used, and covers the methodology for collection and preservation of samples; the time and location of all samples are in the supplementary spreadsheets.

Underway samples

Surface samples for pigment, microscopy and POM were taken underway from the ship's non-toxic supply. Underway sampling was started at two hourly intervals on the first passage leg (20th - 24th March), then resumed on 31st March, upon leaving the D301 stations on the passage to the south of Madagascar. After the work there, the underway sampling was restarted at 6 hourly intervals on the 7th April for the return passage to Durban (the reduced sampling being because of insufficient bottle tops).

CTD samples

Water was collected for pigments, microscopy and POM analysis between the surface and a depth below the chlorophyll maximum. Occasionally, surface samples were drawn from the underway supply when no Niskin bottle was fired at this depth, or there was insufficient water for all demands. As the filtration time for POM samples is longer than for HPLC samples, POM was only sampled at two depths per cast.

Microscopy samples:

Material:

100 ml brown glass bottles

100 ml plastic measuring cylinder

Preservatives:

Lugol

Formaldehyde 4%

The main goal of the phytoplankton sampling is to investigate the phytoplankton taxonomic composition and the spatial and temporal distribution of the different populations. These data will be compared with the pigment analysis and chlorophyll concentration from satellite images of ocean colour. Microscopy samples were collected for the identification of different phytoplankton species back at NOC, using a light inversion microscope.

At each underway location / Niskin bottle, two samples were taken in 100 ml brown glass ('medicine') bottles. For one, 1ml of Lugol was used as the preservative, in the other 1 ml of 4% formaldehyde. (The preservatives were measured into bottles before the water sample was collected.) Lugol allows the identification of diatoms and dinoflagellates in the microscope but destroys the coccoliths of coccolithophorids, which are the main identifying feature of this phytoplankton group. The formaldehyde used with the other samples, preserves the coccolithophorids cells for the microscope counts onshore.

All microscopy samples collected were stored in dark boxes and kept cool.

Pigment samples:

Material:

Filtration equipment
Pressure pump
1 litre plastic measuring cylinder
24 Carboys
GF/F Whatman filters (25 mm diameter, 0.7 μm pore size)
Plastic cryotube vials
Dewar of liquid nitrogen

Samples were drawn from the underway non-toxic supply and from CTD bottles in 5-10 litre plastic carboys wrapped in black plastic bags to keep samples in the dark before filtration. For the collection of pigment samples, two litres of water were filtered through a glass microfibre filter (GF/F Whatman) in filtration equipment. The filtration equipment worked at very low pressure (2 bar) to avoid possible leaks and filter breakages. Once the filtration of each sample was finished the filter was removed from the filter holder of the equipment, folded using tweezers and placed in a cryotube vial. As soon as possible the sample was placed in a dewar to be frozen in liquid nitrogen at –192˚C, and then subsequently kept in a freezer at -80˚C.

Samples were transported back to the UK in a dry shipper and then kept in a -80˚C freezer to await analysis. This will be done using the analytical method HPLC (High Performance Liquid Chromatography).

POM (Particulate Organic Matter) samples:

Material:

(As for pigment analysis, except filters had to be pre-heated beforehand.)

For the POM analysis, samples from the surface and chlorophyll maximum depths were collected from the CTD casts. Surface samples were drawn every twelve hours from the underway supply (00:00 GMT and 12:00 GMT).

4 litres of water were filtered through a microfibre filter (GF/F Whatman) preheated to 450˚C. After filtration, each filter was folded carefully and placed in micropore plastic box or in a cryotube to be frozen in liquid nitrogen. Isotopic analysis will be done onshore.

6 Sediment trap sampling

On March 25, 2006, at 10.55 hours GMT, the sediment trap mooring was released from a depth of 2245 m, at 16°441.9'S, 40° 51.2'E directly underneath the path of the Mozambique eddies. It was originally deployed on March 6, 2005 at 18:13 UTC and equipped with two Technicap PPS-5/2 sediment traps, one in an ASF-bottom frame the other 238 m above, each with a collecting area of 1.0 m^2 and provided with a 1.5 cm honeycomb baffle. Their pre-programmed sampling intervals were 23 days for each of the 24 collecting cups on both traps, starting on March 9, 2005 at 01:00 UTC, thus programmed to end sampling on September 12, 2006. At first it seemed that no communication whatsoever could be established between either deck unit and either Benthos release gear; yet some 45 minutes after release commands were transmitted, the mooring surfaced and was recovered successfully. Since both sediment traps in the mooring were pre-programmed to collect until September 12, 2006, the sampling carrousels would still be at bottle position 17 of 24, so that the large funnel would remain filled with seawater instead of emptying during hoisting. Care was taken to put both traps on deck in a vertical position, after which the motor as well as bottle 18 were removed and the carrousel manually turned to the open position 18 in order to empty the funnel while retaining sample 17, without spilling their poisonous content. Subsequently, the entire carrousel with sample bottles was dismounted from each trap, properly packaged to minimise the risk of spilling the poisonous content through the poor seal of the bottles against their connecting necks, and transferred to the cold room for dark storage at 4°C. Prior to deployment the sample cups had been filled with seawater collected at the deployment depth of each trap and from the actual deployment site, to which a biocide ($HgCl_2$; end-concentration 1.8 g l^{-1}) and a pH-buffer ($Na_2B_4O_7 \cdot 10H_2O$; end concentration 1.8 g l^{-1}) had been added supplemented by 400 ml of milliQ-water to a density slightly in excess of the ambient seawater. A blank sample had been taken for later comparison with the actual collecting cups to determine chemical dissolution fluxes.

As part of a new shipboard protocol, the samples were processed as rapidly as possible in order to draw a time-series of subsamples from the supernate solution of each trap bottle for analysis of dissolved compounds released from the particulate matter. Within 2.5 to 3.5 hours after release (establishing t_0 subsampling), the sample carrousel of the bottom-most trap (MOZ-2B) was manually rotated to the first sample position to remove the top 30 ml of supernate solution from the connecting neck with an acid-cleaned all-PP syringe. About 5 ml was taken to flush the syringe and discarded into the toxic waste container, followed by another 25 ml of which 5 ml was used to flush a syringe-top 0.2 µm Acrodisc filter (into the toxic waste container), and another 5 ml to fill a 6 ml PE-pony vial for shipboard analysis of silica, phosphate and ammonia. The remaining about 15 ml was transferred to an acid-cleaned 50 ml PP bottle for shore-based analysis of pH, density and element composition with respect to the ambient seawater. After a MilliQ-rinse of the syringe, this procedure was repeated consecutively for each sample bottle, so that all bottles could then safely be removed from the carrousel, capped, and stored. The entire procedure was repeated for the topmost trap (MOZ-2A) within

5 to 6 hours after release (establishing t_0 subsampling for MOZ-2A). Subsequent samples of the supernate solution were taken in the same manner but directly from the sample bottles using a 4 ml all-PP syringe, that rendered about 2 ml of supernate solution transferred into acid-cleaned PE pony-vials within 8, 20 and 40 hrs after release (t_1 to t_3) for the bottom trap (MOZ-2B), after which the sample residues were split into 8 aliquots using a modified Baker & Tennant (1996) splitter, which concluded the time-series. However, for the topmost trap (MOZ-2A) it was continued at 10, 21.5, 41, 78.5 and 190 hrs after mooring release, establishing t_1 to t_5. Conveniently, sample bottles 18-24 could be taken as solution blanks, as they had not been sampling. For a first order estimate of the mass flux, the height of the residue in the collecting bottles was measured to the next millimeter and converted into residue volumes (ml) using the bottle-specific equation ($V_{res} = 7.477 + 1.8773*Ht_{res}$).

Shipboard analysis of dissolved silica, phosphate and ammonia of the supernate solution in the collecting bottles of both sediment traps show strongly enhanced excess concentrations with respect to their blank values (i.e. in the collecting cups which had not yet opened prior to recovery), due to decomposition of the particulate matter during deployment (Fig. 17). Analysis at NIOZ and elsewhere will include the determination of salt-free dry weight to obtain the actual mass flux, of major bulk compounds (organic carbon and nitrogen for organic matter, carbonate carbon for $CaCO_3$, and opaline silica), minor and trace elements (Fe, Mn, Mg, Sr, Ba, Al, Ti, K, Th, etc.) as well as the particle specific composition (foraminifera, grain size, dinoflagellates, etc.) and compound specific analysis (biomarkers, $\delta^{15}N$, $\delta^{13}Corg$, etc.).

The sediment trap mooring was redeployed on March 30, 13:50 hours GMT, at 16° 42.7''S, 40° 51.2'E, at almost exactly the position and water depth of the previous mooring site, in order to continue sampling the particle flux for a subsequent time series of 1.5 years. The pre-programmed sampling intervals were kept the same at 23 days for every of the 24 collecting cups, starting on April 1, 2006 at 13:00 UTC, thus ending on October 5, 2007. The same time-series sediment traps were used, i.e. two Technicap PPS-5/2s with a collecting area of 1.0 m^2 , except that the lost baffle of the bottom trap was replaced by a 3 cm square grid provided by the ship, and the motors were replaced. Also the sensor package on the bottom trap was replaced by a new one, including the OBS sensor, and a similar sensor package was mounted on the topmost trap. Both are provided with new Li-batteries to ensure sufficient power to complete their measurements (OBS, tilt, temperature, pressure) every 12 minutes from March 3, 2006, 08:00 through to November 20, 2007, 08:00. Sample bottles were filled with seawater collected at the deployment site and depth of each trap, in which a biocide (16 g of $HgCl_2$; end-concentration 1.8 g l^{-1}) and a pH-buffer (16 g of $Na_2B_4O_7 \cdot 10H_2O$; end concentration 1.8 g l^{-1}) were dissolved, supplemented by milliQ-water (600 ml in 8.0 l of seawater) to a density slightly in excess of the ambient seawater. A blank sample was taken for later comparison with the actual collecting cups to determine in-situ chemical decomposition fluxes, which in turn will be compared with the results from controlled in-situ dissolution experiments (see above). In order to prevent leakage of the biocide solution prior to mooring recovery given the poor closure of the sample bottles against their connecting neck, the latter were not filled. Although this compromises subsequent comparison with the blank values, it can reasonably be accounted for, assuming that the remaining 30 ml will more or less simultaneously be filled with ambient seawater during the initial descent of the mooring. In addition,

several sample vials with known weights of cultured diatoms, biogenic silica, inorganic opaline silica and a silica gel were mounted on the bottom traps to assess in-situ silica dissolution in the same trap solution with respect to the intercepted flux.

7 Multicore geochemistry and biogenic silica cycling experiments

Particulate organic matter, from primary production or of terrestrial origin, settles at the sea floor where it is recycled in the upper layer of the sediment through microbial activity, thereby releasing dissolved nutrients in the upper layers of the sediments. Oxygen supplies the energy needed for this process; when oxygen is depleted, dissolved nitrate will be used as an oxidant. The build-up of dissolved nutrients in the pore waters results in fluxes from the sediment into the overlying water, where concentrations are generally low.

To investigate nutrient fluxes across the sediment -water interface, seven multicore stations were sampled along the extended mooring transect in the Mozambique Channel, to partly repeat and supplement the stations sampled in 2003 and 2005. The positions of the multicore stations, water depth and sediment recovery are listed below.

Station #	Water depth (m)	Pos. latitude (S)	Pos. longitude (E)	Location	Sediment recovery
MC1	509	16º 30.4	39º 58.4	Mozambique margin	Failed
MC2	2240	16º 41.9	40º 50.4	Trap site	Good
MC3	2652	16º 56.2	41º 42.6	bottom Davies Ridge	Good
MC4	2040	16º 57.2	41º 50.2	top Davies Ridge	Good
MC5	2109	17º 03.0	42º 13.6	SW of Juan de Nova	Good
MC6	1565	17º 15.1	42º 59.6	SE of Juan de Nova	Good
MC7	604	17º 16.5	43º 08.4	Madagascar margin	Poor

At all stations, samples were taken with a Royal NIOZ multicorer, equipped with 8 6cm-id cores and 4 10cm-id cores. Immediately upon arrival on deck, the cores were transferred to the temperature-controlled lab, maintained at bottom water temperatures. The shallow station at 500m water depth on the Mozambican side of the channel failed because the multicore penetrated too deep into the soft clayey sediment. In contrast, on the Madagascar slope, even with full weight the multicore could not penetrate the sandy sediment properly and only 1 core containing 15cm of sediment could be recovered. For all other multicores, sufficient sediment could be retrieved.

Unfortunately, the temperature in the Temperature Controlled lab could not be maintained at the required temperature of 3ºC needed for all stations deeper than 1000m, but could only be kept constant at 10ºC, too high to yield reliable pore water data. As a result, no pore water gradients could be obtained during this cruise. From each successful multicore deployment, a 10cm diameter core was

sliced at 1cm intervals for carbonate isotope analysis, including ^{14}C-dating of the core from the sediment trap site, and a 6cm diameter core was retrieved for XRF-scanning at NIOZ.

Biogenic Silica cycling and diagenesis

All dissolution cages that had been mounted on the mooring cables in 2005 came up empty, because the Spectrapor semi-permeable membrane had disappeared completely, despite the presence of a stainless steel protective grid surrounding the membrane. It was therefore impossible to calculate any silica dissolution rates from leftover solid silica phase. Fortunately, additional samples of the diatom *Thalassiosira punctigera* and of the artificial silicates *silicagel*, *aerosil 50* and *aerosil 200* had been secured to the sediment traps as batch incubations. Upon sediment trap recovery, the different silicates were sampled immediately and at regular intervals afterwards to determine the pressure dependence of silica solubility. This sampling time series will be continued at home in the lab.

On the cables of moorings 5A and 6 and attached to the bottom sediment trap, samples of the fresh diatom *Thalassiosira punctigera*, *Ethmodiscus rex* ooze and the artificial silica Aerosil 50, in 4ml Nalgen bottles with filtered sea water, were attached at 550, 1000, 1500, 2000,2250 and 2500 m water depth. Furthermore, samples of the fresh diatom *Thalassiosira punctigera* together with clays, with both fractions separated by a semi-permeable membrane, were incubated at 550, 1250 and 2000m water depth, to study the pressure-dependent interaction between biogenic silica and metal ions originating from the clays.

Water filtration experiments

In order to study the difference in diatom abundance (dead/alive) and species distribution between the chlorophyll maximum layer and the bottom waters, 60L samples were taken from each of the two depths at each CTD station. The seawater was filtered using 0.4µm pore size filters in order to collect any diatoms present. This experiment can potentially reveal how many diatoms sink to the bottom before they completely dissolve in the water column. If a considerable number of diatoms are found in the bottom waters the next step will be to study their silica frustules using microscopy and other surface characterization techniques in order to determine if any kind of alteration took place during sinking.

Acknowledgements

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Appendix A

cruise summary (*.SUM file) of RRS Discovery cruise 64D301B

Cruise Summary Discovery D301B, 2006

Cast types:	abbr.	Event codes:
CTD+SBE37	CTD+SBE37	
CTD+samples	CTD+samples	begin
Pistoncore	PC	bottom
Multicore	mc	end = on board
Mooring deploymen	md	grappled
Mooring recovery	mr	top on board

CODE	Statio	Type	Event	te (dd/mmm/yy	UTC time	latitude degr	latitude min.decm	longitude degr	longitude min.decmi	cast Depth	Comments	CTD file name (.dat)	nuts file name
D301	001	mr	be	24/Mar/2006	11:47	16	32.8	40	8.9		LMC4 released		
D301	001	mr	gr	24/Mar/2006	12:12	16	32.8	40	8.7				
D301	001	mr	end	24/Mar/2006	12:27	16	32.7	40	8.3		LMC4 on board		
D301	002	CTD+samples	be	24/Mar/2006	14:38	16	30.9	39	57.5				
D301	002	CTD+samples	bo	24/Mar/2006	15:11	16	31.2	39	56.8	600	CTD1	D301B_01	CTD060325AR1
D301	002	CTD+samples	end	24/Mar/2006	15:51	16	31.7	39	56.1				
D301	003	mc	be	24/Mar/2006	17:07	16	30.7	39	58.1				
D301	003	mc	end	24/Mar/2006	17:43	16	31.1	39	57.3	600	failure		
D301	004	mc	be	24/Mar/2006	18:15	16	30.0	39	58.5				
D301	004	mc	bo	24/Mar/2006	18:31	16	30.4	39	58.5	500	MC1		
D301	004	mc	end	24/Mar/2006	18:45	16	30.6	39	58.4				
D301	005	CTD+samples	be	24/Mar/2006	20:30	16	32.8	40	9.0				
D301	005	CTD+samples	end	24/Mar/2006	22:19	16	35.3	40	7.3	1300	CTD2	D301B_02	CTD060325AR1
D301	006	CTD+samples	be	25/Mar/2006	02:17	16	39.4	40	36.2				
D301	006	CTD+samples	bo	25/Mar/2006	03:03	16	39.9	40	35.2	1986	CTD4	D301B_03	CTD060325AR1
D301	006	CTD+samples	end	25/Mar/2006	04:35	16	40.7	40	34.0				
D301	006	mr	be	25/Mar/2006	05:04	16	38.7	40	37.1		LMC5 released		

Cruise Summary Discovery D301B, 2006

Cast types:	abbr.	Event codes:
CTD+SBE37	CTD+SBE37	
CTD+samples	CTD+samples	begin
Pistoncore	PC	bottom
Multicore	mc	end = on board
Mooring deploymen	md	grappled
Mooring recovery	mr	top on board

CODE	Statio	Type	Event	te (dd/mmm/yy	UTC time	latitude degr	latitude min.decm	longitude degr	longitude min.decmi	cast Depth	Comments	CTD file name (.dat)	nuts file name
D301	006	mr	gr	25/Mar/2006	05:14	16	38.6	40	36.1				
D301	006	mr	end	25/Mar/2006	06:48	16	40.0	40	33.9		LMC5 on board		
D301	007	mr	be	25/Mar/2006	08:44	16	41.9	40	50.8		trap released		
D301	007	mr	gr	25/Mar/2006	09:40	16	41.9	40	50.9				
D301	007	mr	end	25/Mar/2006	10:00	16	41.8	40	50.1		trap on board		
D301	008	mr	be	25/Mar/2006	13:29	16	45.7	41	3.7		LMC5A released		
D301	008	mr	gr	25/Mar/2006	13:46	16	45.7	41	3.3				
D301	008	mr	end	25/Mar/2006	13:58	16	45.4	41	2.9		LMC5A on board		
D301	009	mc	be	25/Mar/2006	16:55	16	42.0	40	50.9				
D301	009	mc	bo	25/Mar/2006	17:49	16	41.9	40	50.4	2311	MC2		
D301	009	mc	end	25/Mar/2006	18:40	16	41.8	40	50.0				
D301	010	CTD+samples	be	25/Mar/2006	19:22	16	41.6	40	49.8	2300	CTD5	D301B_04	CTD060326AR1
D301	010	CTD+samples	end	25/Mar/2006	21:56	16	41.1	40	48.2				
D301	011	CTD+samples	be	26/Mar/2006	00:05	16	43.9	41	3.9		CTD6	D301B_05	CTD060326AR1
D301	011	CTD+samples	end	26/Mar/2006	02:13	16	45.8	41	2.5				
D301	012	CTD+samples	be	26/Mar/2006	12:32	16	52.5	41	28.0				
D301	012	CTD+samples	bo	26/Mar/2006	12:55	16	51.9	41	27.5	2700	CTD8	D301B_06	CTD060326AR1

Cruise Summary Discovery D301B, 2006

Cast types:	abbr.	Event codes:
CTD+SBE37	CTD+SBE37	
CTD+samples	CTD+samples	begin
Pistoncore	PC	bottom
Multicore	mc	end = on board
Mooring deploymen	md	grappled
Mooring recovery	mr	top on board

CODE	Stati	Type	Event	te (dd/mmm/yy	UTC time	latitude degr	latitude min.decm	longitude degr	longitude min.decmi	cast Depth	Comments	CTD file name (.dat)	nuts file name
D301	012	CTD+samples	end	26/Mar/2006	13:33	16	51.5	41	28.2				
D301	013	mr	be	26/Mar/2006	05:37	16	58.3	41	58.4		LMC7 released		
D301	013	mr	gr	26/Mar/2006	08:23	16	59.0	41	56.6				
D301	013	mr	end	26/Mar/2006	08:40	16	59.4	41	56.4		LMC7 on board		
D301	014	mc	be	26/Mar/2006	14:35	16	57.3	41	50.4	2050	MC4		
D301	014	mc	end	26/Mar/2006	16:08	16	57.1	41	50.0			testing	
D301	015	CTD+samples	be	26/Mar/2006	17:44	16	55.2	41	41.3	2700	CTD9	D301B_07	CTD060327AR1
D301	015	CTD+samples	end	26/Mar/2006	20:00	16	54.9	41	40.1				
D301	016	CTD+samples	be	26/Mar/2006	21:47	16	58.5	41	55.8				
D301	016	CTD+samples	end	26/Mar/2006	23:42	16	58.5	41	55.8	2000	CTD10	D301B_08	CTD060327AR1
D301	017	CTD+samples	be	27/Mar/2006	03:04	17	6.8	42	28.7				
D301	017	CTD+samples	bo	27/Mar/2006	03:49	17	7.1	42	28.7	2174	CTD12	D301B_09	CTD060327AR1
D301	017	CTD+samples	end	27/Mar/2006	05:11	17	7.2	42	29.2				
D301	018	mr	be	27/Mar/2006	05:35	17	6.2	42	29.1		LMC8 released		
D301	018	mr	gr	27/Mar/2006	06:20	17	6.7	42	28.9				
D301	018	mr	end	27/Mar/2006	07:12	17	6.9	42	29.6		LMC8 on board		
D301	019	mr	be	27/Mar/2006	10:06	17	14.7	43	2.0		LMC9 released		

Cruise Summary Discovery D301B, 2006

Cast types:	abbr.	Event codes:
CTD+SBE37	CTD+SBE37	
CTD+samples	CTD+samples	begin
Pistoncore	PC	bottom
Multicore	mc	end = on board
Mooring deploymen	md	grappled
Mooring recovery	mr	top on board

CODE	Statio	Type	Event	te (dd/mmm/yy)	UTC time	latitude degr	latitude min.decm	longitude degr	longitude min.decmi	cast Depth	Comments	CTD file name (.dat)	nuts file name
D301	019	mr	gr	27/Mar/2006	10:47	17	14.9	43	2.3				
D301	019	mr	end	27/Mar/2006	11:11	17	14.9	43	2.3		LMC9 on board		
D301	020	mc	be	27/Mar/2006	11:50	17	14.6	42	59.2		MC6		
D301	020	mc	end	27/Mar/2006	13:09	17	15.7	42	59.8				
D301	021	CTD+samples	be	27/Mar/2006	15:05	17	10.6	42	45.6		CTD13	D301B_10	CTD060328AR1
D301	021	CTD+samples	bo	27/Mar/2006	15:45	17	10.5	42	45.6				
D301	021	CTD+samples	end	27/Mar/2006	16:50	17	10.4	42	45.7				
D301	022	CTD+samples	be	27/Mar/2006	18:36	17	14.9	43	1.9		CTD14	D301B_11	CTD060328AR1
D301	022	CTD+samples	end	27/Mar/2006	21:30	17	15.10	43	2.50				
D301	023	CTD+samples	be	27/Mar/2006	21:34	17	16.20	43	6.90		CTD15	D301B_12	CTD060328AR1
D301	023	CTD+samples	end	27/Mar/2006	22:45	17	16.4	43	7.2	2695			
D301	024	mc	be	27/Mar/2006	23:40	17	16.2	43	7.9	800	MC7 failed		
D301	024	mc	end	28/Mar/2006	00:20	17	16.4	43	8.2				
D301	025	mc	be	28/Mar/2006	00:27	17	16.3	43	8.3	600	MC7 failed		
D301	025	mc	end	28/Mar/2006	01:00	17	16.8	43	8.4				
D301	026	md	be	28/Mar/2006	04:54	17	15.8	43	2.7		LMC9 deployment		
D301	026	md	end	28/Mar/2006	06:04	17	14.80	43	2.00	1450	mooring released		

Cruise Summary Discovery D301B, 2006

Cast types:	abbr.	Event codes:
CTD+SBE37	CTD+SBE37	
CTD+samples	CTD+samples	begin
Pistoncore	PC	bottom
Multicore	mc	end = on board
Mooring deploymen	md	grappled
Mooring recovery	mr	top on board

CODE	Statio	Type	Event	te (dd/mmm/yy)	UTC time	latitude degr	latitude min.decm	longitude degr	longitude min.decmi	cast Depth	Comments	CTD file name (.dat)	nuts file name
D301	027	md	be	28/Mar/2006	07:33	17	7.8	42	29.4		LMC8 deployment		
D301	027	md	end	28/Mar/2006	08:45	17	6.20	42	28.50	2195	mooring released		
D301	028	md	be	28/Mar/2006	11:53	16	59.8	41	52		LMC7 deployment		
D301	028	md	end	28/Mar/2006	12:50	16	58.60	41	56.31		mooring released		
D301	29	CTD+SBE37	be	28/Mar/2006	15:32	17	2.7	42	12.4		Seacat calibration	D301B_13	
D301	29	CTD+SBE37	bo	28/Mar/2006	16:07	17	2.7	42	12.3		1000 m		
D301	29	CTD+SBE37	end	28/Mar/2006	16:59	17	2.5	42	12.3				
D301	030	CTD+samples	be	28/Mar/2006	17:39	17	2.3	42	12.3		CTD11	D301B_14	CTD060329AR1
D301	030	CTD+samples	end	28/Mar/2006	19:54	17	1.70	42	13.00				
D301	031	mc	be	28/Mar/2006	20:45	17	3.0	42	13.8		MC5		
D301	031	mc	bo	28/Mar/2006	21:34	17	3.00	42	13.60				
D301	031	mc	end	28/Mar/2006	22:24	17	3.20	42	13.30				
D301	032	mc	be	29/Mar/2006	01:26	16	56.3	41	43.3		MC3		
D301	032	mc	bo	29/Mar/2006	02:22	16	56.2	41	42.6				
D301	032	mc	end	29/Mar/2006	03:20	16	55.7	41	42.4				
D301	033	md	be	30/Mar/2006	03:45	16	50.8	41	26.8		LMC6 deployment		
D301	033	md	end	30/Mar/2006	05:14	16	52.30	41	28.80		mooring released		

Cruise Summary Discovery D301B, 2006

Cast types:	abbr.	Event codes:
CTD+SBE37	CTD+SBE37	
CTD+samples	CTD+samples	begin
Pistoncore	PC	bottom
Multicore	mc	end = on board
Mooring deploymen	md	grappled
Mooring recovery	mr	top on board

CODE	Stati	Type	Event	te (dd/mmm/yy	UTC time	latitude degr	latitude min.decm	longitude degr	longitude min.decmi	cast Depth	Comments	CTD file name (.dat)	nuts file name
D301	034	md	be	30/Mar/2006	07:49	16	43.6	41	3.2		LMC5A deployment		
D301	034	md	end	30/Mar/2006	09:20	16	45.00	41	3.20		mooring released		
D301	035	md	be	30/Mar/2006	12:20	16	41.7	40	50.9		trap mooring deployment		
D301	035	md	end	30/Mar/2006	13:51	16	42.70	40	51.20		trap mooring released		
D301	36	CTD+samples	be	30/Mar/2006	16:36	16	49	41	16.1		CTD7	D301B_15	CTD060331AR1
D301	36	CTD+samples	bo	30/Mar/2006	17:40	16	49.1	41	15.9				
D301	36	CTD+samples	end	30/Mar/2006	19:15	16	49.4	41	15.8				
D301	37	CTD+samples	be	31/Mar/2006	00:03	16	35.8	40	22.6		CTD3	D301B_16	CTD060331AR1
D301	37	CTD+samples	end	31/Mar/2006	01:46	16	37	40	20.7				
D301	038	md	be	31/Mar/2006	03:56	16	36.7	40	36.2		LMC5 deployment		
D301	038	md	end	31/Mar/2006	05:06	16	38.80	40	36.70		mooring released		
D301	039	md	be	31/Mar/2006	07:42	16	32.5	40	9.9		LMC4 deployment		
D301	039	md	end	31/Mar/2006	08:24	16	32.90	40	8.40		mooring released		

Appendix B

cruise summary (*.SUM file) of RRS Discovery cruise 64D302

Cruise Summary Discovery D302, 2006

Cast types:	abbr.	
CTD+SBE37	CTD+SBE37	Event codes:
CTD+samples	CTD+samples	
Pistoncore	PC	begin
XBT	xbt	bottom
Mooring deployment	md	end = on board
Mooring recovery	mr	grappled
POD launching	pod	top on board

CODE	Station	Type	Event	date (dd/mmm/yyyy)	UTC time	latitude degr	latitude min.decm	longitude degr	longitude min.decmi	cast Depth	Comments
D302	040	xbt - T7	be	31/Mar/2006	17:55	17	15.5	40	8.9		T7
D302	041	xbt - T5	be	01/Apr/2006	05:00	19	17.5	40	9.0		T5
D302	042	xbt - T7	be	01/Apr/2006	06:21	19	32.0	40	10.0		T7
D302	043	xbt - T5	be	01/Apr/2006	07:54	19	46.0	40	18.4		T5
D302	044	xbt - T7	be	01/Apr/2006	09:33	20	0.8	40	26.2		T7
D302	045	xbt - T5	be	01/Apr/2006	11:07	20	14.3	40	35.0		T5
D302	046	xbt - T7	be	01/Apr/2006	12:43	20	28.1	40	43.2		T7
D302	047	xbt - T5	be	01/Apr/2006	13:57	20	39.2	40	49.8		
D302	048	CTD+samples	be	01/Apr/2006	14:17	20	39.6	40	50.2		
D302	048	CTD+samples	bo	01/Apr/2006	15:16	20	39.7	40	50.9	2863	
D302	048	CTD+samples	end	01/Apr/2006	16:48	20	40.2	40	51.2		
D302	049	xbt - T7	be	01/Apr/2006	17:54	20	49.9	40	56.1		
D302	050	xbt - T5	be	01/Apr/2006	19:00	21	0.0	41	2.1		
D302	051	xbt - T7	be	01/Apr/2006	20:06	21	9.8	41	7.9		
D302	052	CTD+samples	be	01/Apr/2006	20:21	21	10.2	41	8.3		
D302	052	CTD+samples	bo	01/Apr/2006	22:00	21	10.8	41	8.9	3381	
D302	052	CTD+samples	end	01/Apr/2006	22:59	21	11.0	41	9.5		
D302	053	xbt - T5	be	02/Apr/2006	00:13	21	20.2	41	14.1		
D302	054	xbt - T7	be	02/Apr/2006	01:23	21	30.0	41	19.7		

Cruise Summary Discovery D302, 2006

Cast types:	abbr.
CTD+SBE37	CTD+SBE37
CTD+samples	CTD+samples
Pistoncore	PC
XBT	xbt
Mooring deployment	md
Mooring recovery	mr
POD launching	pod

Event codes:
begin
bottom
end = on board
grappled
top on board

CODE	Station	Type	Event	date (dd/mmm/yyyy)	UTC time	latitude degr	latitude min.decm	longitude degr	longitude min.decmi	cast Depth	Comments
D302	055	CTD+samples	be	02/Apr/2006	02:42	21	39.9	41	25.5		
D302	055	CTD+samples	bo	02/Apr/2006	03:45	21	40.0	41	25.2	3354	
D302	055	CTD+samples	end	02/Apr/2006	05:29	21	40.1	41	26.0		
D302	056	xbt - T7	be	02/Apr/2006	06:38	21	50.0	41	31.7		
D302	057	xbt - T5	be	02/Apr/2006	07:50	22	0.0	41	38.0		
D302	058	CTD+samples	be	04/Apr/2006	05:56	27	20.4	46	58.3		
D302	058	CTD+samples	bo	04/Apr/2006	06:40	27	27.2	46	58	1635	
D302	058	CTD+samples	end	04/Apr/2006	08:30	27	23.0	46	57.2		
D302	059	xbt - T5	be	04/Apr/2006	10:26	27	10.9	46	54.7		
D302	060	xbt - T7	be	04/Apr/2006	11:30	27	2.6	46	51.1		
D302	061	mr	gr	04/Apr/2006	14:23	26	55.5	46	45.9		
D302	061	mr	end	04/Apr/2006	15:01	26	57.3	46	45.5		
D302	062	xbt - T7	be	04/Apr/2006	19:04	26	52.3	46	46.8		
D302	063	CTD+samples	be	05/Apr/2006	03:16	25	39.2	46	11.4	185	
D302	063	CTD+samples	end	05/Apr/2006	03:46	25	39.6	46	11.0		
D302	064	CTD+samples	be	05/Apr/2006	04:29	25	41.2	46	11.6	714	
D302	064	CTD+samples	end	05/Apr/2006	05:35	25	42.2	46	10.4		
D302	065	CTD+samples	be	05/Apr/2006	06:43	25	45.9	46	14.8	1053	
D302	065	CTD+samples	end	05/Apr/2006	08:20	25	44.9	46	14.5		

Cruise Summary Discovery D302, 2006

Cast types:	abbr.
CTD+SBE37	CTD+SBE37
CTD+samples	CTD+samples
Pistoncore	PC
XBT	xbt
Mooring deployment	md
Mooring recovery	mr
POD launching	pod

Event codes:
begin
bottom
end = on board
grappled
top on board

CODE	Station	Type	Event	date (dd/mmm/yyyy)	UTC time	latitude degr	latitude min.decm	longitude degr	longitude min.decmi	cast Depth	Comments
D302	066	xbt - T7	be	05/Apr/2006	10:00	25	53.6	46	18.0		
D302	067	mr	gr	05/Apr/2006	11:39	26	0.2	46	20.4		
D302	067	mr	end	05/Apr/2006	12:32	25	59.4	46	19.4		
D302	068	CTD+samples	be	05/Apr/2006	14:32	26	0.1	46	20.9		
D302	068	CTD+samples	bo	05/Apr/2006	15:09	26	0.0	46	20.5	1595	
D302	068	CTD+samples	end	05/Apr/2006	16:24	25	59.7	46	20.2		
D302	069	CTD+samples	be	05/Apr/2006	18:24	26	8.8	46	25.1	1828	
D302	069	CTD+samples	end	05/Apr/2006	20:08	26	10.0	46	23.8		
D302	070	CTD+samples	be	05/Apr/2006	21:55	26	16.8	46	29.7	2097	
D302	070	CTD+samples	end	05/Apr/2006	23:55	26	16.9	46	29.6		
D302	071	CTD+samples	be	06/Apr/2006	02:24	26	25.1	46	33.2		
D302	071	CTD+samples	bo	06/Apr/2006	03:12	26	25.1	46	32.8	2402	
D302	071	CTD+samples	end	06/Apr/2006	04:29	26	25.4	46	31.9		
D302	072	mr	gr	06/Apr/2006	07:00	26	27.5	46	29.8		
D302	072	mr	end	06/Apr/2006	08:06	26	29.0	46	27.4		
D302	073	xbt - T7	be	06/Apr/2006	09:55	26	32.6	46	36.6		
D302	074	CTD+samples	be	06/Apr/2006	11:03	26	39.9	46	39.3	2320	
D302	074	CTD+samples	end	06/Apr/2006	13:20	26	42.1	46	37.7		
D302	075	xbt - T7	be	06/Apr/2006	14:52	26	46.8	46	43.0		

Cruise Summary Discovery D302, 2006

Cast types:	abbr.
CTD+SBE37	CTD+SBE37
CTD+samples	CTD+samples
Pistoncore	PC
XBT	xbt
Mooring deployment	md
Mooring recovery	mr
POD launching	pod

Event codes:
begin
bottom
end = on board
grappled
top on board

CODE	Station	Type	Event	date (dd/mmm/yyyy)	UTC time	latitude degr	latitude min.decm	longitude degr	longitude min.decmi	cast Depth	Comments
D302	076	CTD+samples	be	06/Apr/2006	16:11	26	54.2	46	47.0		
D302	076	CTD+samples	bo	06/Apr/2006	16:53	26	54.50	46	46.80	2149	
D302	076	CTD+samples	end	06/Apr/2006	18:12	26	54.90	46	46.50		
D302	077	CTD+samples	be	07/Apr/2006	02:45	26	7.7	47	46.0		
D302	077	CTD+samples	bo	07/Apr/2006	03:56	26	7.4	47	45.3	3913	
D302	077	CTD+samples	end	07/Apr/2006	05:46	26	6.9	47	44.6		
D302	078	mr	gr	07/Apr/2006	06:41	26	7.5	47	45.9		
D302	078	mr	end	07/Apr/2006	08:24	26	7.5	47	45.9		
D302	079	pod	be	07/Apr/2006	11:31	25	56.7	47	30		commenced deployment 4 POD's
D302	079	pod	end	07/Apr/2006	11:41	25	56.8	47	29.9		completed deployment POD's

Appendix C

Mooring information file of RRS Discoverycruise 64D301B

Mooring deployment March 2005 Mozambique Channel

		Location of deployment							meters										
Mooring	Latitude		Longitude		Water	measurement	instrument	Instrument	below	Recording		Start	Start	Deployment		Oceano AR-861 rele		Argos buoy	
ID	deg S	min S	deg E	min E	depth	Type	Type	ID	surface	interval(s)	DSU No.	date	time(UTC)	date	time	Nr.	code	ID/SN	Argos code
LMC4	16	32.90	40	8.40	1350	ADCP	LR	3439	591	1800		31-Mar		31-Mar	8:24	164	04d4	CML 60672	23201
						CTD	SBE-37-SM	4140	625	360		31-Mar	04:26			177	04e2		
						CTD	SBE-37-SM	4345	1075	360		31-Mar	04:30						
						ADCP	LR	3616	1340	1800		31-Mar							
LMC 5	16	38.80	40	36.70	1992	ADCP	LR	3549	591	1800		31-Mar	03:00	31-Mar	5:06	152	04c7	CML 60671	23490
						currentmeter	RCM9	205	991	1200	12231	31-Mar	03:46			153	04c8		
						CTD	SBE-37-SM	4347	1025	300		30-Mar	08:34						
						currentmeter	RCM11	35	1491	1200	13526	31-Mar	03:47						
						CTD	SBE-37-SM	2676	1975	300		30-Mar	08:37						
						ADCP	LR	3700	1995	1800		31-Mar	12:30						
LMC5A	16	45.00	41	3.20	2403	CTD	SBE-37-SM	2656	110	360		30-Mar	03:30	30-Mar	9:20	161	04O1	CML 60675	23127
						CTD	SBE-37-SM	3622	200	360		30-Mar	03:30			160	04cf		
						CTD	SBE-37-SM	2670	400	360		30-Mar	03:40						
						currentmeter	RCM9	351	481	1200	3346?	30-Mar	04:45						
						dissolution cage		1	500										
						dissolution cage		2	900										
						currentmeter	RCM11	242	992	1200	12683	30-Mar	04:32						
						dissolution cage		3	1250										
						dissolution cage		4	1500										
						currentmeter	RCM11	206	1491	1200	11389	30-Mar	04:48						
						CTD	SBE-37-SM	2655	1525	360		30-Mar	03:43						
						CTD	SBE-37-SM	4353	1975	360		30-Mar	03:49:00						
						CTD	SBE-37-SM	4349	2375	360		30-Mar	03:52:00						
						ADCP	LR	3702	2391	1800		30-Mar							
LMC6	16	52.30	41	28.80		currentmeter	RCM11	244	591	1200	13527	29-Mar	17:47	30-Mar	5:14	159	04ce	CML 60677	23005
						CTD	SBE-37-SM	2657	625	360		29-Mar	17:40			158	04cd		
						currentmeter	RCM11	237	991	1200	14759	29-Mar	17:47						
						currentmeter	RCM11	201	1491	1200	7322	29-Mar	17:47						
						CTD	SBE-37-SM	2668	1975	360		29-Mar	17:40						
						CTD	SBE-37-SM	2649	2375	360		29-Mar	17:40						
						dissolution cage		6	2500										
						ADCP	LR	3596	2689	1800		30-Mar	05:00						
		Location of deployment							meters										

Mooring deployment March 2005 Mozambique Channel

Mooring	Latitude		Longitude		Water	measurement	instrument	Instrument	below	Recording		Start	Start	Deployment		Oceano AR-861 rele		Argos buoy	
ID	deg S	min S	deg E	min E	depth	Type	Type	ID	surface	interval(s)	DSU No.	date	time(UTC)	date	time	Nr.	code	ID/SN	Argos code
LMC7	16	58.60	41	56.31	1995	ADCP	LR	3552	621	1800				28-Mar	12:50	175	04df	CML 60674	22830
						CTD	SBE-37-SM	4351	650	360		28-Mar	12:00			178	04e3		
						currentmeter	RCM11	238	992	1200	13749	28-Mar	09:54						
						currentmeter	RCM11	239	1491	1200	13742	28-Mar	09:52						
						CTD	SBE-37-SM	4348	1525	360		28-Mar	12:00						
LMC8	17	6.20	42	28.50	2199	ADCP	LR	3440	596	1800				28-Mar	8:45	172	04dc	CML 60669	23495
						CTD	SBE-37-SM	4350	625	360		28-Mar	08:00			179	04e4		
						currentmeter	RCM11	203	994	1200	13531	28-Mar	05:57						
						CTD	SBE-37-SM	4354	1025	360		28-Mar	?						
						currentmeter	RCM11	241	1493	1200	13747	28-Mar	06:04:50						
						currentmeter	RCM11	245	2092	1200	13746	28-Mar	08:00:00						
						CTD	SBE-37-SM	4352	2125	360		28-Mar	06:08:10						
LMC9	17	14.80	43	2.00	1428	ADCP	LR	3641	628	1800				28-Mar	6:04	173	04dd	CML 69021	25382
						currentmeter	RCM11	204	1026	1200	12748	28-Mar	03:27			147	04c2		
						currentmeter	RCM11	236	1326	1200	13740	27-Mar	17:30						
trap	16	42.70	40	51.20	2240	currentmeter	RCM11	45	1950	1800	12091	30-Mar	10:01	30-Mar	13:51	Benthos		ID1770	SN12074
						datalogger	NIOZ	A3	2010	720		30-Mar	08:00			1003	8G enable		
						trap	PPS5	051	2011	1987200		01-Apr	13:00				8E release		
						trapmotor	Technicap	03-235	2011	1987200		01-Apr	13:00			997	6H enable		
						currentmeter	RCM11	49	2150	1800	12232	30-Mar	10:05				6F release		
						CTD	SBE-37-SM	3624	2200	360		30-Mar	08:24						
						datalogger	NIOZ	A9	2244	720		30-Mar	08:00						
						trap	PPS5	9-026	2245	1987200		01-Apr	13:00						
						trapmotor	Technicap	03-236	2011	1987200		01-Apr	13:00						
						bottomframe	NIOZ	ASF 010	2244										

Appendix D

Rotation schedule sediment traps

Mooring MOZ-3: deployed March 30, 2005 at 13:50 GMT during LOCO/D301B (EL LOCO)

prospective recovery by early 2008

all dates and times in UTC **position:** **16º 41.7'S, 40º 51.2'E**

position number	date UTC dd-m-yy hr:min	sampling	date UTC dd-m-yy hr:min	Collecting interval (days)	bottle number
0	1-4-2006 13:00	start sample #1	1-apr-06 13:00		
1	24-4-2006 13:00	start sample #2	24-apr-06 13:00	**23**	**MOZ-3-A/B-1**
2	17-5-2006 13:00	start sample #3	17-mei-06 13:00	**23**	**MOZ-3-A/B-2**
3	9-6-2006 13:00	start sample #4	9-jun-06 13:00	**23**	**MOZ-3-A/B-3**
4	2-7-2006 13:00	start sample #5	2-jul-06 13:00	**23**	**MOZ-3-A/B-4**
5	25-7-2006 13:00	start sample #6	25-jul-06 13:00	**23**	**MOZ-3-A/B-5**
6	17-8-2006 13:00	start sample #7	17-aug-06 13:00	**23**	**MOZ-3-A/B-6**
7	9-9-2006 13:00	start sample #8	9-sep-06 13:00	**23**	**MOZ-3-A/B-7**
8	2-10-2006 13:00	start sample #9	2-okt-06 13:00	**23**	**MOZ-3-A/B-8**
9	25-10-2006 13:00	start sample #10	25-okt-06 13:00	**23**	**MOZ-3-A/B-9**
10	17-11-2006 13:00	start sample #11	17-nov-06 13:00	**23**	**MOZ-3-A/B-10**
11	10-12-2006 13:00	start sample #12	10-dec-06 13:00	**23**	**MOZ-3-A/B-11**
12	2-1-2007 13:00	start sample #13	2-jan-07 13:00	**23**	**MOZ-3-A/B-12**
13	25-1-2007 13:00	start sample #14	25-jan-07 13:00	**23**	**MOZ-3-A/B-13**
14	17-2-2007 13:00	start sample #15	17-feb-07 13:00	**23**	**MOZ-3-A/B-14**
15	12-3-2007 13:00	start sample #16	12-mrt-07 13:00	**23**	**MOZ-3-A/B-15**
16	4-4-2007 13:00	start sample #17	4-apr-07 13:00	**23**	**MOZ-3-A/B-16**
17	27-4-2007 13:00	start sample #18	27-apr-07 13:00	**23**	**MOZ-3-A/B-17**
18	20-5-2007 13:00	start sample #19	20-mei-07 13:00	**23**	**MOZ-3-A/B-18**
19	12-6-2007 13:00	start sample #20	12-jun-07 13:00	**23**	**MOZ-3-A/B-19**
20	5-7-2007 13:00	start sample #21	5-jul-07 13:00	**23**	**MOZ-3-A/B-20**
21	28-7-2007 13:00	start sample #22	28-jul-07 13:00	**23**	**MOZ-3-A/B-21**
22	20-8-2007 13:00	start sample #23	20-aug-07 13:00	**23**	**MOZ-3-A/B-22**
23	12-9-2007 13:00	start sample #24	12-sep-07 13:00	**23**	**MOZ-3-A/B-23**
24	5-10-2007 13:00	end sample #24	5-okt-07 13:00	**23**	**MOZ-3-A/B-24**