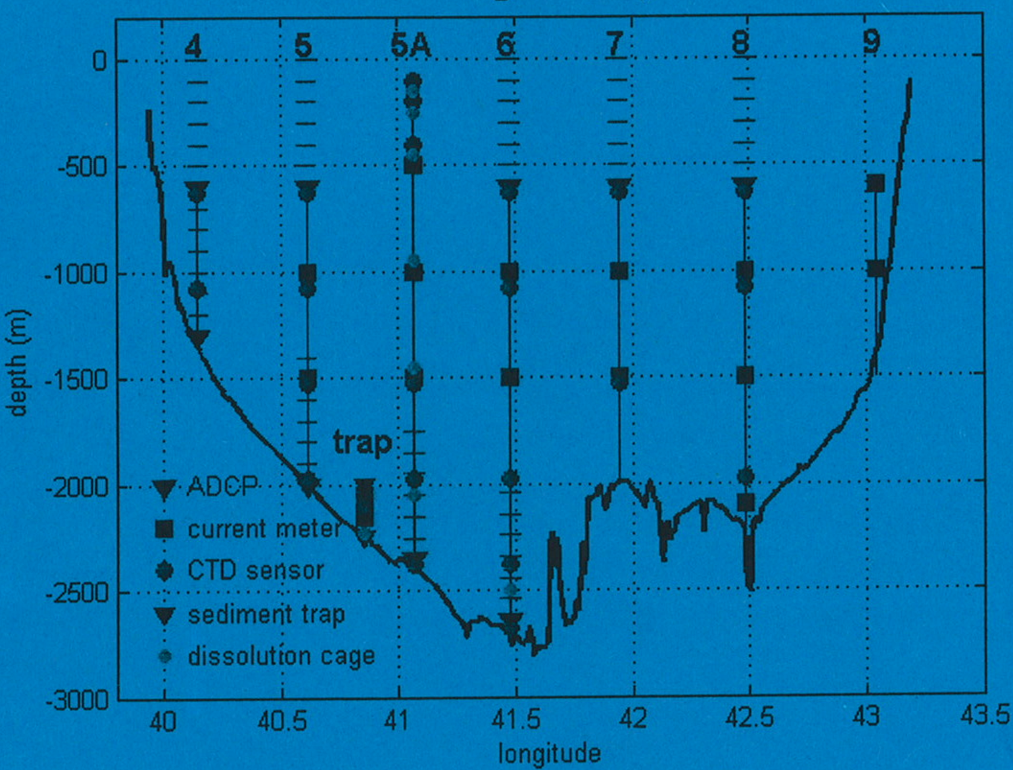
RRS Discovery Cruise Report:

Cruise D289B

Mozambique Channel, 26 February – 15 March 2005

H. Ridderinkhof
Chief Scientist

LOCO moorings D289B, 2005-2006



Royal NIOZ, Texel, 2005

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

1 Cruise Narrative

1.1 Highlights

a: RV Discovery cruise D289B in the Mozambique Channel

b: Expedition Designation (EXPOCODE): 64D289B

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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: February 26, 2005 to March 15, 2005

1.2 Cruise Summary Information

Summary

Early in the on Saturday 26 February RRS Discovery left the harbor of Durban, South Africa and 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 and a piston core at the narrowest section of the Mozambique Channel. RRS Discovery left the quay one day later than planned because the vessel's air conditioning was broken. However, it appeared that the system could not be repaired and we left the quay without air conditioning on board. Transit to the western (Mozambique) side of the section took 4 days and 5 hours.

On Wednesday 02/03/05 in the early evening we arrived at the section. Because it was dark we could not start with recovery of the moorings. Therefore first a hydrographic station was occupied, followed by a multi- and pistoncore station at some 1000 m depth.

On Thursday 03/03/05 at 05.00 local time the first mooring, LMC4, was released and recovered. Before recovering the next mooring, LMC5, first a hydrographic station was occupied at a distance of roughly 1 nm from the mooring location. Mooring LMC5 was released and recovered in the early afternoon. The mooring with sediment traps was reached just before sundown. The mooring was released but was not spotted at the surface before darkness set in. It was decided to continue the program with a hydrographic station and a multi- and piston core station at 2500 m waterdepth during the night.

On Friday 04/03/05 the longest mooring, LMC5A, was released and recovered. The whole procedure took some 2.5 hours. While on transit further to the east we got a fax message with the position of the drifting trap mooring. Apparently the ARGOS beacon on top of the mooring worked well. RRS Discovered turned 180 degrees and set course for the drifting mooring which was found a few hours later. The mooring could be recovered just before darkness set in. Again, night time was use for a hydrographic station and a multi- and piston core station, now at 2700 m depth.

On Saturday 05/03/05 it became clear that, despite some ultimate efforts by the UK Foreign Office, we were not permitted to work in the French economical zone surrounding Juan de Nova. Therefore the original cruise plan was changed. We sailed back to the Mozambique side of the channel, meanwhile preparing and servicing the instruments from the moorings. This servicing also included fixing the SBE (salinity, temperature) sensors to the CTD frame and performing a deep hydrographic cast for calibration of these mooring sensors. Two such hydrographic stations were occupied on Saturday. Meanwhile influential scientists in the UK, France and the Netherlands were approached by phone and asked to use their influence to obtain the French permission.

On Sunday 06/03/05 the first mooring, LMC4, was redeployed early in the morning, followed by a hydrographic station including calibration of SBE sensors. In the afternoon first mooring LMC5 was redeployed, followed by the trap mooring. During night time RRS Discovery sailed back to a waterdepth of some 2000 m to obtain a multi- and a pistoncore sample.

On Monday 07/03/03 the redeployment of moorings in the Mozambique economical zone was finished with the deployment of the long moorings LMC5A and LMC6. Late afternoon and early evening were used for an hydrographic station and a multi-core sampling in the deepest part of the channel. From 21.00 onwards activities were finished while waiting for permission to work in the French economical zone.

On Tuesday 08/03/03 RRS Discovery stayed close to mooring LMC7 without any activities. Contact with the shore made clear that the situation had changed in that the French authorities now were busy in reviewing the request for permission. Meanwhile it was decided that, for reasons of efficiency, our work should start with recovery of mooring LMC8. Therefore RRS Discovery sailed slowly towards this mooring during night time.

Diplomatic clearance was finally obtained around midday on Wednesday 09/03/05. Immediately mooring LMC8 was recovered, followed by two hydrographic stations.

On Thursday 10/03/05 work started at sunrise, 05.00 am, with the recovery of the short mooring LMC9. This mooring was immediately redeployed using serviced instruments from previous moorings. Then, in the morning, a combined CTD-calibration SBE's station was carried out at 1900 m waterdepth. In the afternoon mooring LMC8 was redeployed and the evening and night was used for 2 more CTD stations.

On Friday 11/03/05 our activities were finished with the recovery and redeployment of mooring LMC9. Work started at 05.00 am and was finished at 08.00 am. Then RRS Discovery set course to Durban where the vessel arrived on Tuesday 15/03/05.

Cruise Track

The cruise was carried out from Durban, South Africa to Durban. The main work area was at the narrowest section of the Mozambique Channel where hydrographic sections were performed, moorings were recovered, serviced and redeployed, and cores (multi-coring and piston coring) were obtained from the seafloor on the western slope of the channel. The complete cruise track is shown in figure 1.

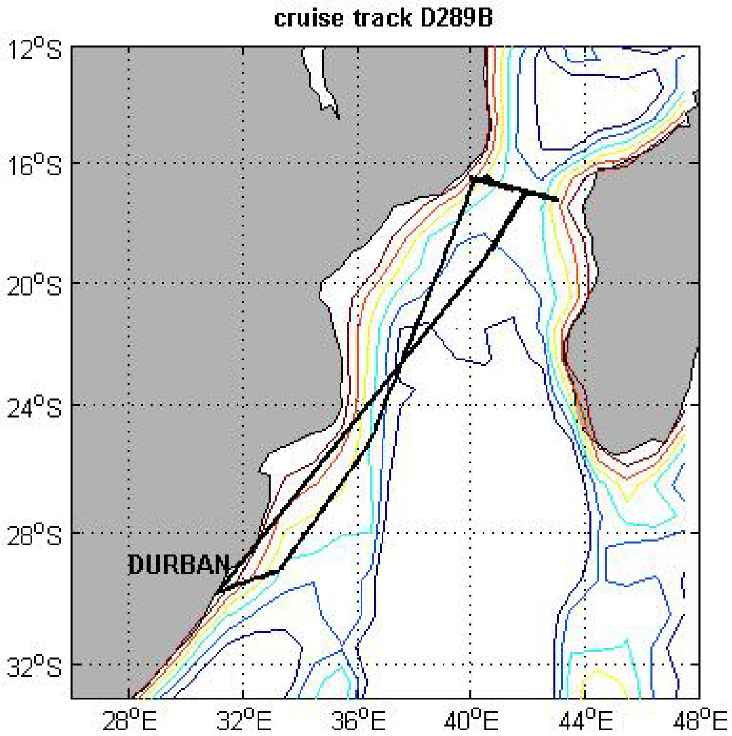


Figure 1.Cruise track of RRS Discovery cruise 64D289B

Hydrographic Stations

A total of 13 CTD casts was recorded, including one short test cast. On all of these casts, except for the test cast, water samples were taken for the determinations of nutrient, dissolved oxygen and, less frequently, salinity. 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. On 4 stations SBE instruments from the moorings were attached to frame for calibration purposes. During these casts the CTD was stopped every 100 m for a period of about 1 minute to obtain stable temperature and conductivity measurements

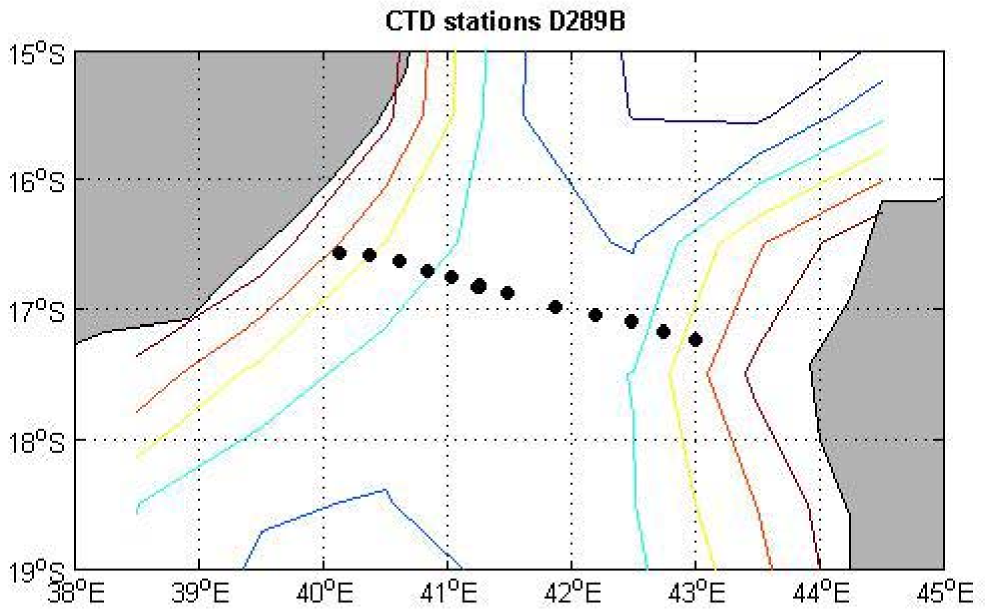


Figure 2. Distribution of hydrographic stations. The isobaths at 200, 500, 1000, 2000 and 3000 m are indicated. Stations that were used also for calibration purposes have been indicated.

Hydrographic Sampling

During the up-cast of each CTD/rosette station up to 17 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.

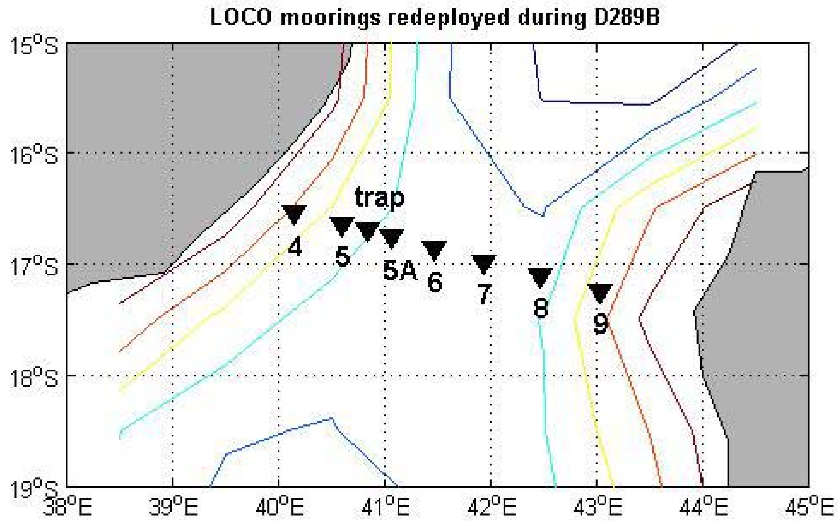
Depth (m)	Samples
Bottom	Oxygen, nutrients
2500	Salinity, oxygen, nutrients
2000	Oxygen, nutrients
1500	Oxygen, nutrients
1250	Oxygen, nutrients
1000	Oxygen, nutrients
900	Oxygen, nutrients
800	Oxygen, nutrients
700	Oxygen, nutrients
600	Oxygen, nutrients
500	Oxygen, nutrients
400	Oxygen, nutrients
300	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

The major goal of this 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 5. The measuring interval of the physical instruments ranges from 5 minutes (T-S sensors), 15 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 November 2006.

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



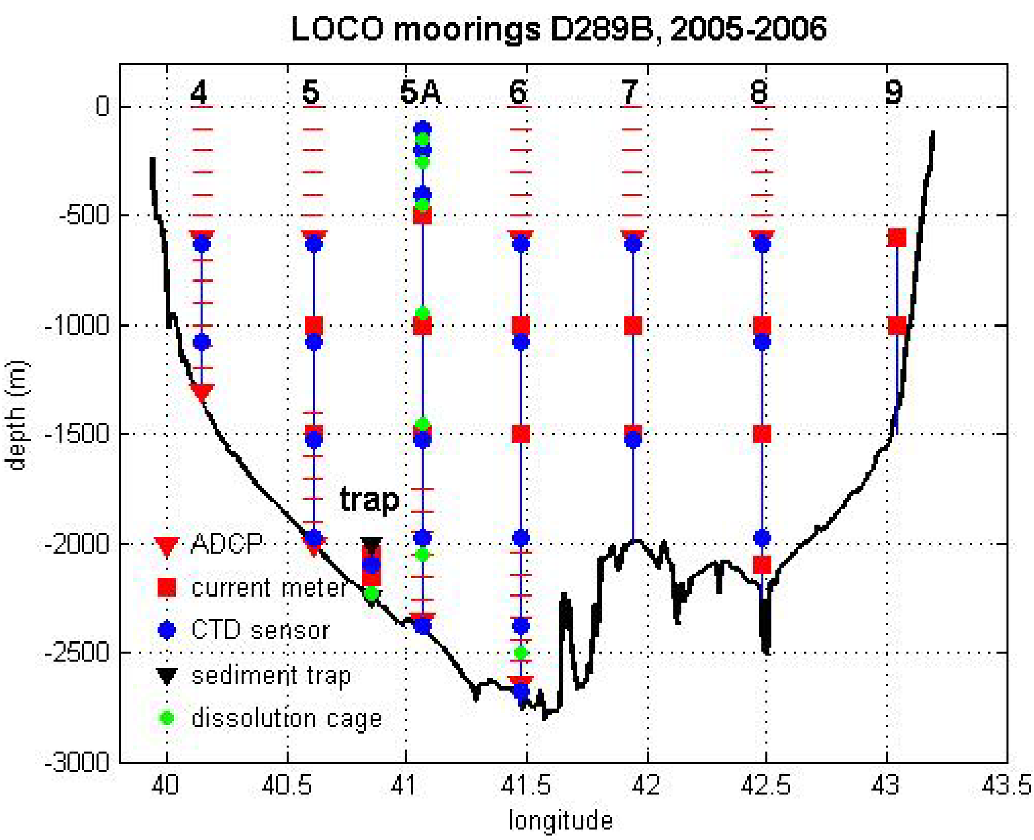


Figure 3. Position of long-term moorings in Mozambique Channel (top) and vertical distribution of the instruments (bottom).

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 4 shows the positions of the Multicore stations.

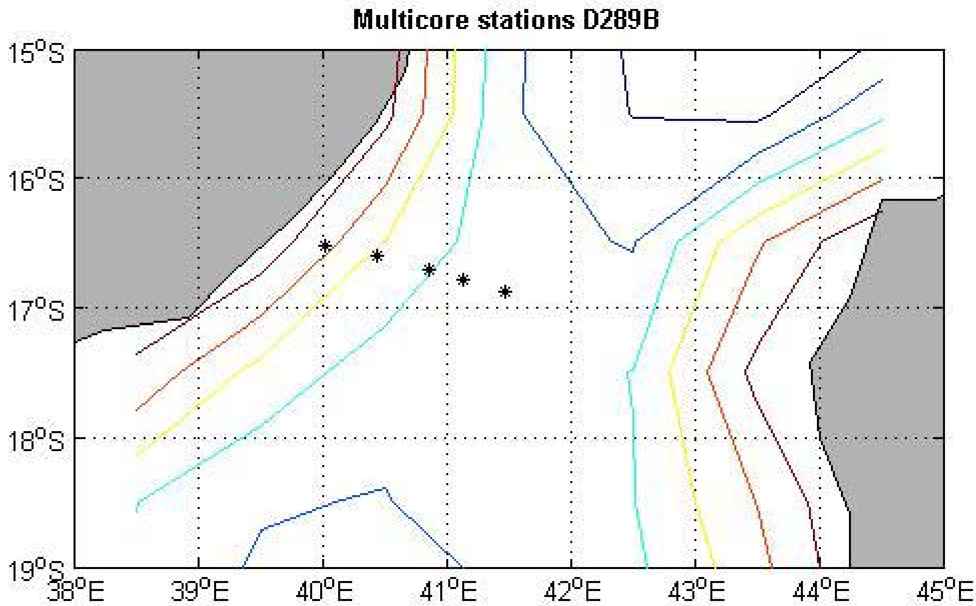


Figure 4. Position of the Multicore stations at the western side of the section.

Pistoncore stations

On the western, Mozambican , side of the section 4 Pistoncore stations were sampled, all in combination with sampling the seafloor sediment with a multicore. Only at the deepest multicore station near the centre of the channel no pistoncore sampling was done. Figure 4 shows the positions of the pistoncore stations.

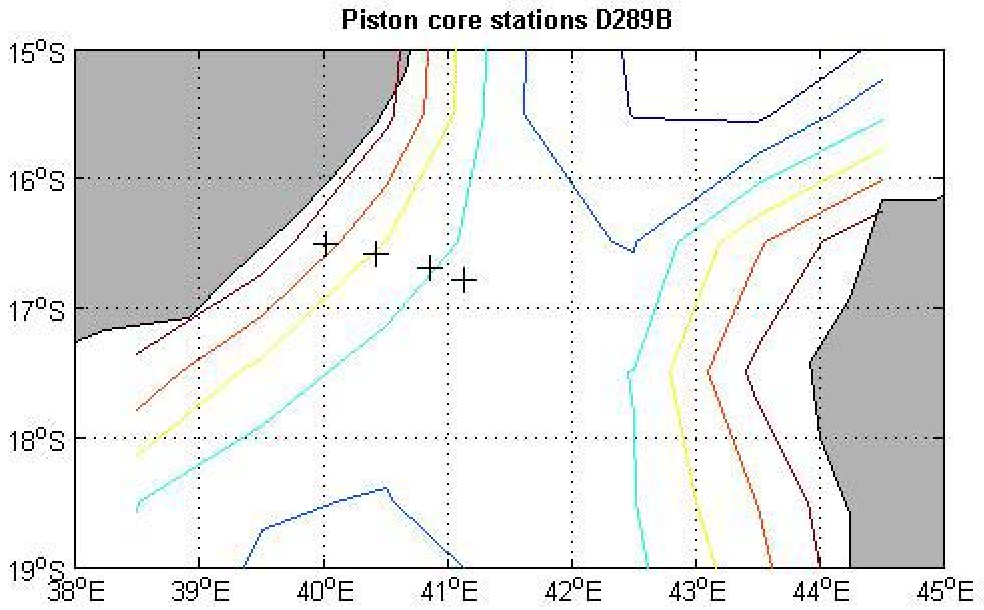


Figure 5. Position of the pistoncore stations at the western side of the section

1.3 Scientific Programme and Methods

The goal of this D289B 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 3) to further assess the sediment biogeochemistry along the western side of the channel and 4) to obtain sediment cores for accessing the geological archive using pistoncoring on the western slope of the channel

Long-term observations with moorings (see figure 3)

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, during the previous cruise in November 2003 3 ADCP's appeared not to function. Then, it was decided to decrease the number of ADCP's on the top of the moorings from 6 to 4 and near the bottom on the western side from 4 to 3. After recovery of the moorings during the present cruise it appeared that one ADCP had leaked and was damaged completely. Thus, 9 ADCP's were now available for deployment. 5 were placed on the top of 5 moorings and 4 near the bottom on the western side of the channel. The near-bottom ADCP's on the western side (moorings 4, 5A, 6,7) are intended to observe the magnitude of the undercurrent carrying NADW equatorward, as discovered during the pilot experiment. 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. Due to time constraints, the westernmost planned CTD station some 12 nm to the west of mooring LMC4, and a station in the center of the channel, in between mooring LMC6 and LMC7, were skipped.

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.

Accessing the geological archive

The 4th goal was to carry out a pilot study on the evolution of ocean currents and hydrographic properties on geological time scales, given the surprisingly high quality of bottom sediment recovered by the Multicorer on the Mozambique side of the channel during the previous cruise in 2003. For that purpose, a total of 7 pistoncore stations were planned on the Mozambique margin of the channel, associated with the long-term moorings stations, and another 3 during transit on the way back to Durban.

1.4 Preliminary Results

Data return from the moored instruments

The recovery of all moorings and instruments went successfully. The data return was:

- ADCP's

7 RDI LongRangers had been deployed. Of these 1, from the top of mooring LMC4, had been leaking and was full of seawater. The settings of the near bottom ADCP from mooring LMC6 appeared to be wrong (WM7 instead of WM1). Therefore this ADCP recorded only the first 7 bins. The other 5 ADCP's have functioned well.

- Current meters

16 current meters had been deployed, 14 RCM11 and 2 RCM8 from Aanderaa. All current meters have functioned well

- SBE salinity and temperature sensors.

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

- Sediment traps

The sediment trap from the top of the mooring, 238 m above the seafloor has functioned well. The other trap in a bottom frame on the seafloor did not function, due to a current leakage in the motor emptying the batteries soon after deployment. 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

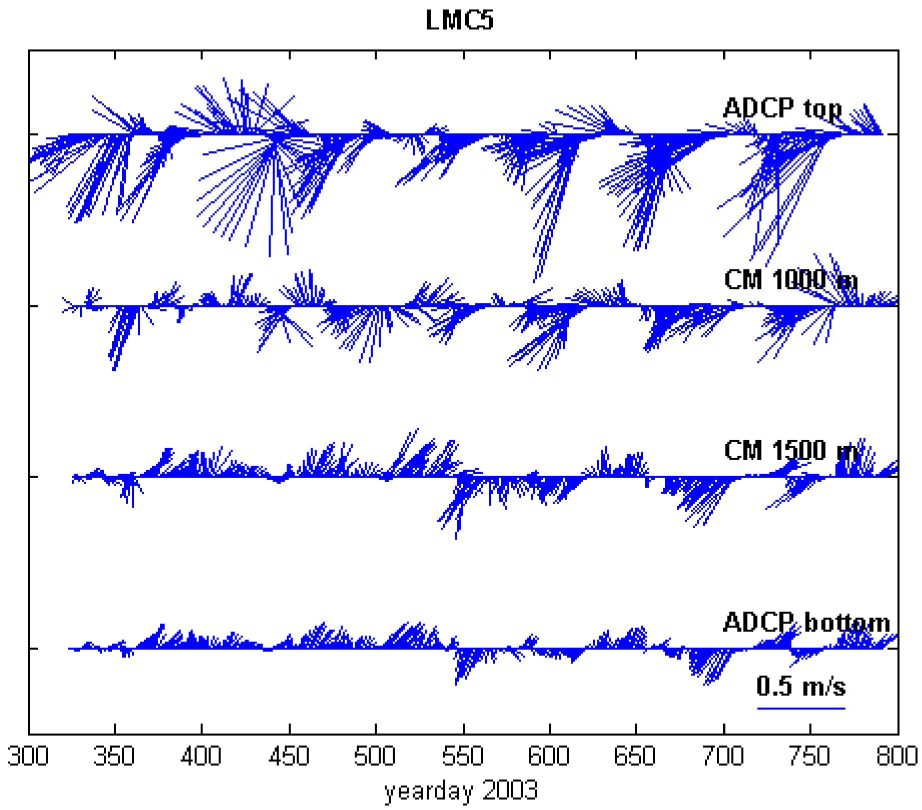


Figure 6. Low-pass filtered currents from mooring LMC5. Currents observed with both ADCP's have been vertically averaged

Figure 6 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 1000 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. Eddies seem to be weaker in the austral winter of 2004 (in the period around yearday 500-550). Roughly 10 eddies seem to have passed the mooring array in some 17 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, especially during the first 200 days of observations, 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 deep CTD cast. Every 100 m the frame was kept at the same vertical position for a minute 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. As an example the results of this procedure is shown in figure 7 for sensor 2658.   Appendix D gives the results for all sensors.

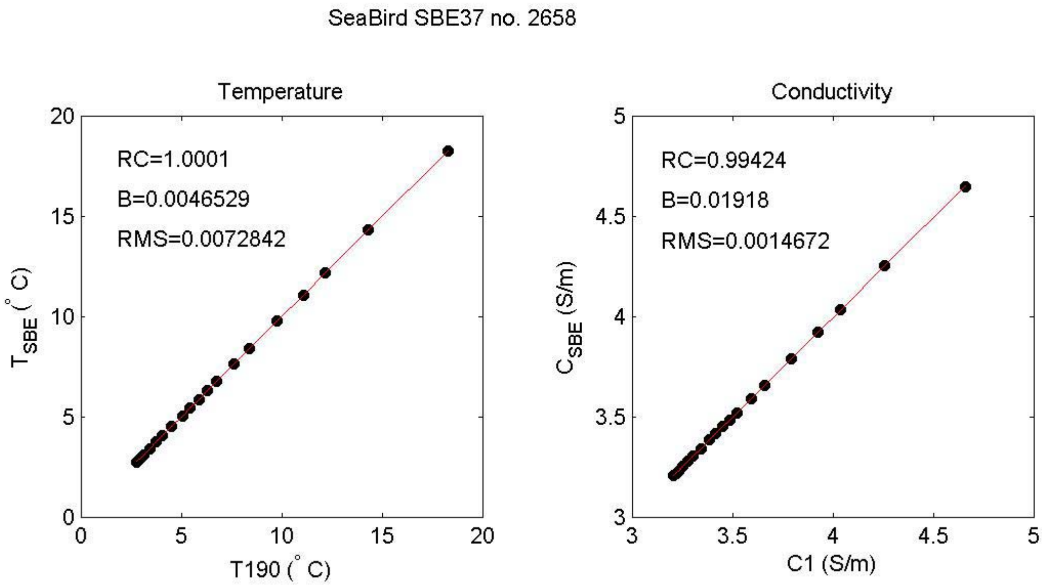


Figure 7. Calibrattion values for SBE sensor 2658 as obtained from comparison with the calibrated CTD sensor.

Hydrographic observations

Figure 8 shows a T-S plot of all observations as obtained along the mooring section in the Mozambique Channel .

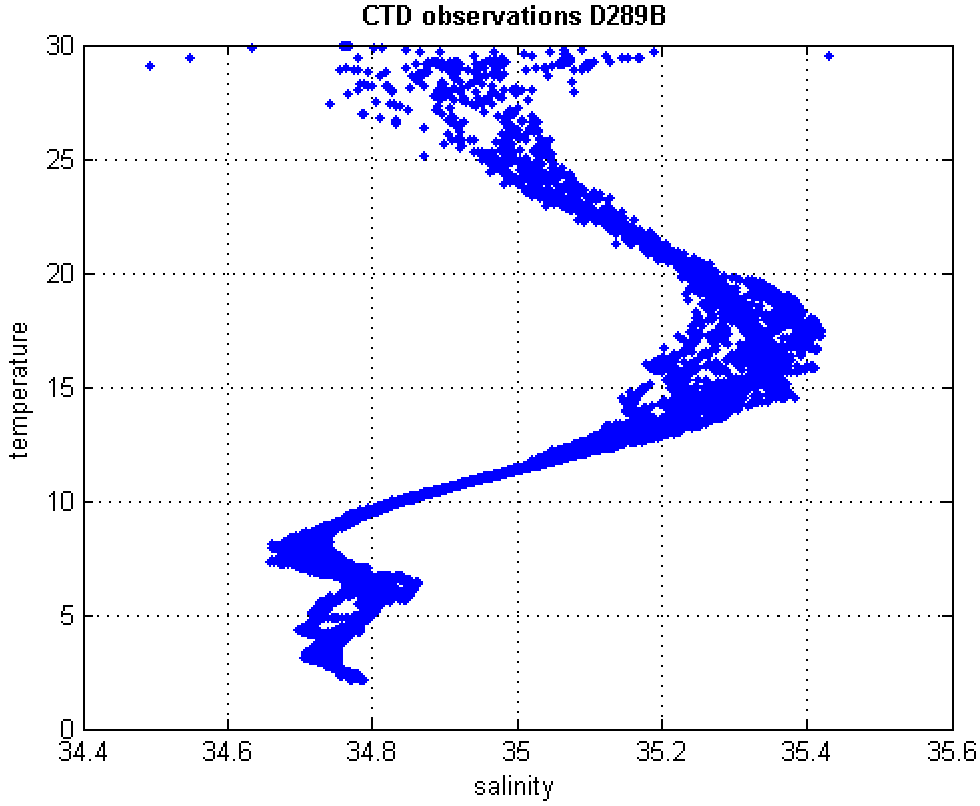
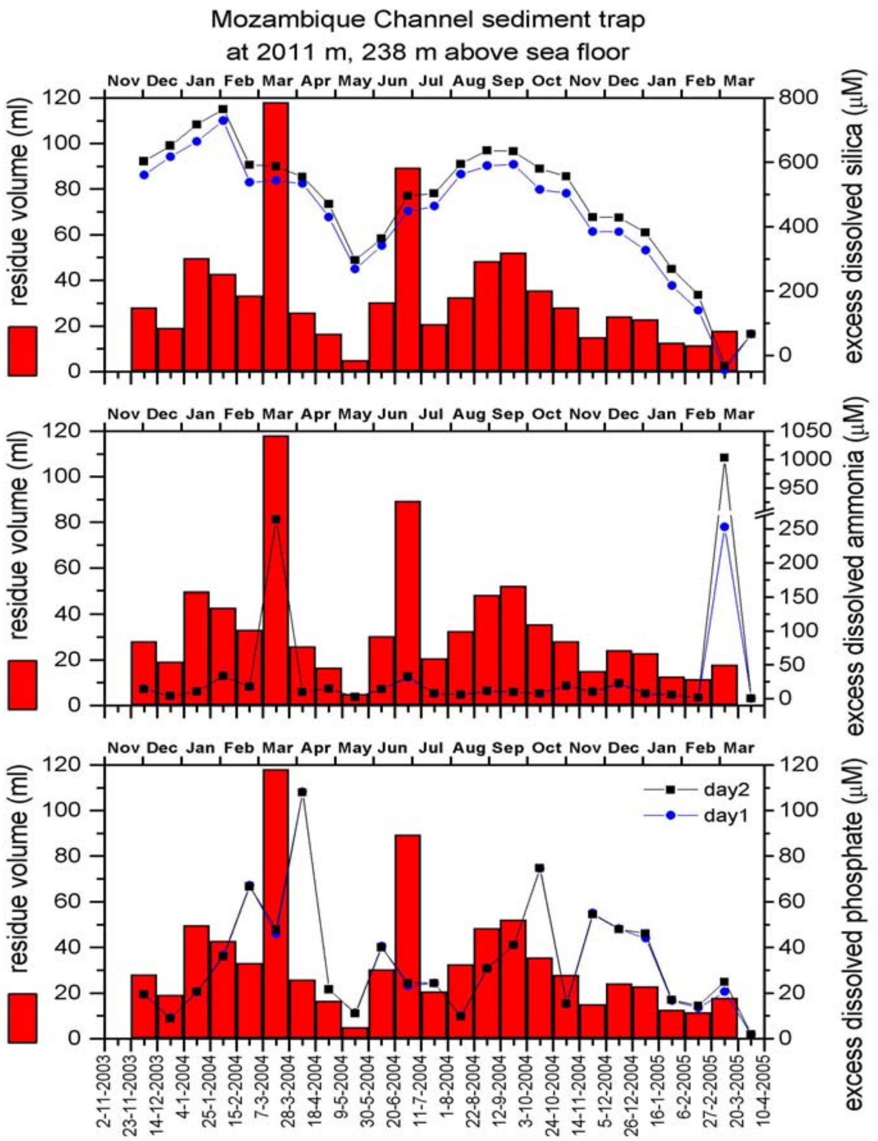


Figure 8. Temperature as a function of salinity along the mooring section in the Mozambique Channel

Sediment trap fluxes

A preliminary characterisation of the magnitude and temporal variability of the particle fluxes settling through the sediment trap at 2011 m depth (238 m above the bottom) can be deduced from the residue volume in the collecting cups and the concentration of dissolved silica and phosphate (Fig. 9).



The tri-weekly resolved time-series from late November, 2003 through early March, 2005, show two pronounced maxima in residue volume, one in March 2004 and one in late June/early July 2004. However, dissolved silica and phosphate concentrations in the sample cups are relatively low for either of these maxima, suggesting that both received a considerable input from sediment resuspension which typically contain relatively little and low reactive mineral phases, as opposed to the highly reactive particulate matter settling out from pelagic export productivity. Current meter measurements at 500 m depth from the nearby mooring suggest that the March 2004 maximum is related to the strongest Mozambique Eddy passing through the channel during the mooring period (Fig. 10a). By contrast, the June/July maximum seem to be associated with enhanced internal wave activity as indicated by the initial drop and subsequent high variability in temperature and salinity as recorded by the CTD mounted on the sediment trap mooring itself (Fig. 10 b). Both maxima are superimposed on an overall bi-/tri-modal distribution in residue volume with enhanced values in early austral summer of 2003-2004 and to a lesser extent in 2004-2005, as well as in austral spring of 2004, and are separated by a pronounced minimum in austral winter of 2004 (Fig. 9). Dissolved silica concentrations mimic this seasonal pattern, yet become subdued towards the later collecting intervals, i.e. for early austral summer 2005, due to the relatively short reaction time available prior to measurement. Although more reactive, labile biogenic phosphate often show lagged concentration maxima with respect to both dissolved silica and residue volumes, probably in response to the N-nutrient limitation in the seasonal pelagic production cycle.

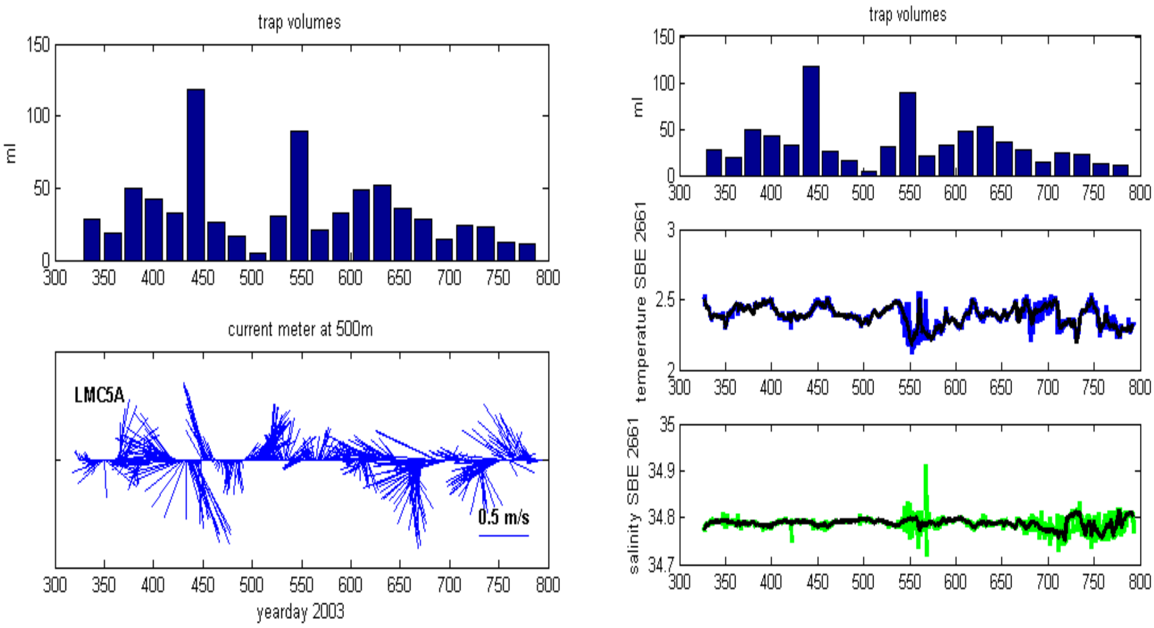


Fig. 10. Sediment trap residue volumes at 2011 m depth, current strength at 500 m depth (left panel) as well as near bottom temperature and salinity (right panel) showing the relationship between maxima in particle flux (upper panel), and maxima in Mozambique eddy and internal wave activity (lower panels), respectively.

Multicore geochemistry, preliminary results

First results show that pore water nitrate and ammonium profiles reflect the highest input of organic matter in the shallowest stations near the Mozambique coast, with organic matter input decreasing downslope into the deepest part of the Mozambique Channel. Below 2100m, the input of organic matter is too low for nitrate to be used to depletion (fig.10). The station sampled in the deepest part in the middle of the channel at 2695m is enriched compared to the other deep stations, suggesting that organic matter originating from the shallower parts of the slope, possibly from the Madagascar site of the channel, accumulates at this station.

Pistoncores: variability on geological time-scales

Although only 4 of the 10 planned pistoncore stations could be carried out, the pilot study showed that suitable coring sites with penetration depths to at least 10 m could be achieved. Compared with results from a coring cruise by the RV Meteor just a few weeks earlier, penetration depths are considerably larger than off the Zambezi river further south. Also the Holocene sediment cover seems to be more extensive and deposited at higher rates, although this needs to be verified by core-scanning and subsample analysis of the yet un-opened cores after arrival at NIOZ. Similar to the Meteor' results, magnetic susceptibility measurements combined with qualitative analysis of the sediment indicate some contribution by turbidites, whereas condensed winnowed sediments deep downcore indicate a drastic change in ocean circulation through the Mozambique Channel.

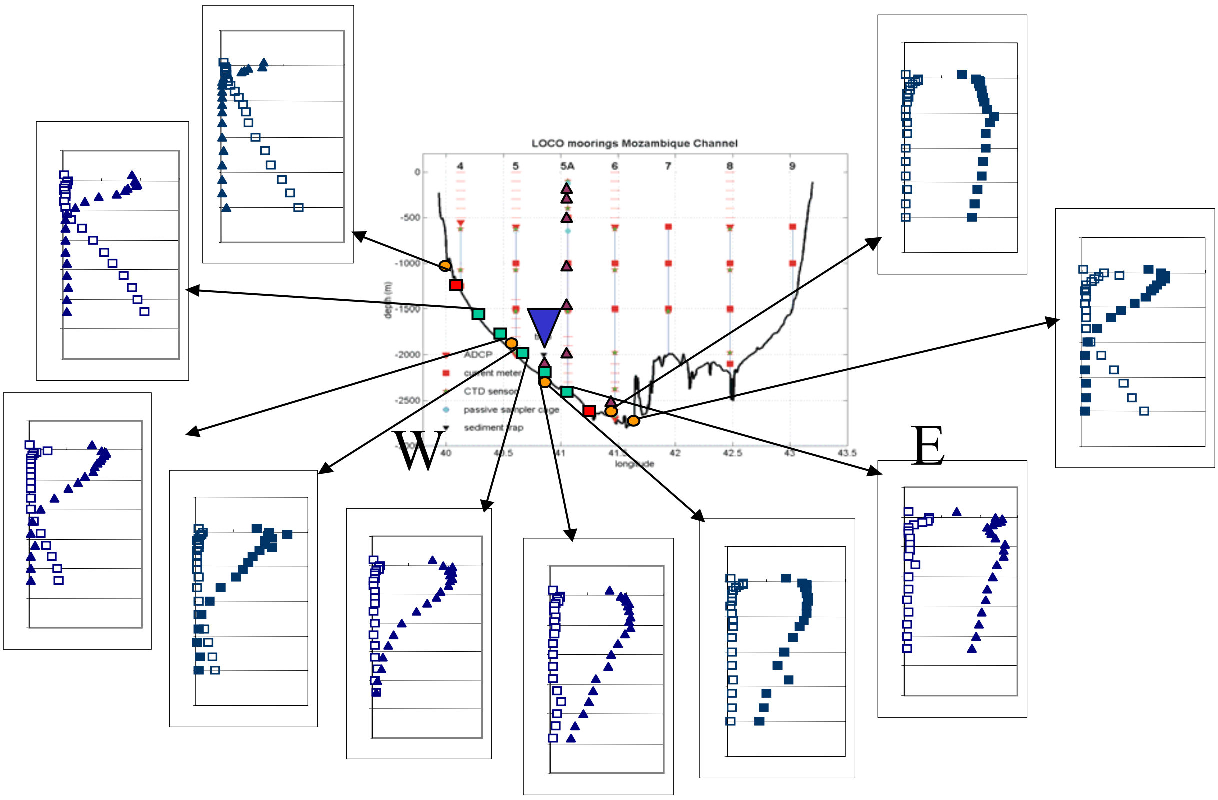


Fig. 10: Profiles of dissolved nitrate (solid symbols) and dissolved ammonium (open squares) along the mooring transect in the Mozambique Channel, from stations sampled in 2003 and 2005. On the transect, green squares represent stations sampled in 2003, orange circles represent stations sampled in 2005. In addition, dissolution cages deployed on the mooring lines are shown as purple triangles.

1.5 Major Problems Encountered during the Cruise

Mooring recovery and redeployment went very smoothly and successfully. All releases, except for one Benthos release on the trap mooring, responded immediately upon the acoustic wake-up calls.

The air conditioning of the ship was broken. This seriously affected the comfort and working on the vessel. Day and night working on the section for one week was about the limit. A longer period would not have been safe for the people on board

Because of the delayed permission to service the LOCO moorings on the eastern margin of the Mozambique Channel, the coring programme on the western side had to be aborted, and only 4 combined Multi- and pistoncore as well as an individual Multicore could be taken in the western Mozambique Channel and non at all during transit. For that particular reason, the primary targets of the coring programme could not be met, with obvious consequences for the implementation of subsequent research programmes based on the pilot study.

1.6 Lists 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
Sharyn Crawford	NIOZ	NL	Chemical analyses
Jan van Ooyen	NIOZ	NL	Nutrients, oxygen
Lorendz Boom	NIOZ	NL	Coring
Yvo Witte	NIOZ	NL	Moorings
Willem Polman	NIOZ	NL	Coring
Jack Schilling	NIOZ	NL	Moorings
Theo Hillebrand	NIOZ	NL	Mooring instruments
Margriet Hiehle	NIOZ	NL	CTD
Martin Laan	NIOZ	NL	electronics
Furu Mienis	NIOZ	NL	PhD student Piston Coring
Pasha Karamiarakhloo	University Utrecht	NL	MsC student – Current meters
Janine Nauw – van der Vegt	University Utrecht	NL	PostDoc – Mooring instruments
Anna von der Heydt	University Utrecht	NL	PostDoc – Mooring instruments
Terence Edwards	SOC	UK	CTD
Paul Duncan	SOC	UK	Computers
Darren Young	SOC	UK	CTD
Rhys Roberst	SOC	UK	Mooring winch

2 Underway Measurements

Navigation

Differential GPS receiver for the determination of the position. The data from the receiver were recorded every ten seconds in the underway data logging system.

Echo Sounding

The 3.5 kHz echo sounder was used on board to determine the water depth. The uncorrected depths from this echo sounder were recorded in the underway data logging system.

Thermo-Salinograph Measurements

The Sea Surface Temperature, Salinity, Fluorescence and optical transmission were measured continuously with an AQUAFLOW thermo-salinograph system with the water intake at a depth of about 2 m.

Vessel mounted ADCP measurements

A 75 kHz vessel mounted ADCP (RDI) recorded the current field continuously. However, these data require considerable effort to become a coherent set. The post-processing includes calibration with data from the lowered ADCP.

3 Hydrographic measurements - Descriptions, Techniques, and Calibrations

Rosette Sampler and Sampler Bottles

A 25 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.

Salinity Measurements

Water was drawn from the samplers into a 0.5 litre glass sample bottle for the salinity determination after 3 times rinsing. The sample bottles had a massive rubber stopper as well as a screw lid. Salinity of water samples (SALNTY) was determined on board by means of an Guildline Autosal 8400A salinometer. The salinometer was used in a laboratory container, fitted with an air conditioning system. This kept the surrounding air temperature constant within 1°C. The readings of the instrument were performed by computer, giving the average and statistics of 10 consecutive readings. For each sample 3 salinity determinations were carried out. From each deep CTD/rosette cast an extra duplicate sample was drawn. Salinity determinations from the duplicate samples obtained from independent runs were used to determine the reproducibility of the salinity determination.

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 colorimetrical 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

The SBE 9/11+ CTD was fitted with temperature sensor SN2118 and conductivity sensor SN995. For the data collection SEASAVE software, version 4.224, supplied by SBE, was used. The CTD data were recorded with a frequency of 24 data cycles per second. On-line a correction was applied for the sampling time difference due to the forced flushing through a tube system between temperature and salinity sensor. After each CTD cast the data were copied to a hard disk of the ship's computer network, and a daily back-up copy was made on tape. Back on Texel these data have been downloaded into the NIOZ computer network. Separate copies of the back up were taken directly from Durban to Texel.

The up-cast data files were sub-sampled to produce files with CTD data corresponding to each water sample, taken with the rosette sampler. After the determination of the final calibration of the CTD system these values were corrected accordingly.

After the cruise the raw down-cast CTD data were processed with the software supplied by SBE. A correction was applied for the temperature change between the temperature and conductivity sensor due to heat exchange with the flushing tube and conductivity sensor, and for different response times of both sensors. Mean values of the readings were produced for 1 dbar pressure intervals. Consecutively the parameter values in physical units were determined using the final calibration constants.

4 Sediment trap sampling

On March 3, 2005, at 15.00 hours GMT, the sediment trap mooring was released from a depth of 2245 m, at 16.4282°S, 40.5113°E directly underneath the path of the Mozambique eddies. It was originally deployed on November 22, 2003 at 07:42 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 21 days for each of the 24 collecting cups on both traps, starting on November 23, 2003 at 01:00 UTC, thus ending on April 10, 2005. At first it seemed that the mooring did not come up on release. However, revisitation of the mooring site later that night resulted in no response from the releases at all, indicating that the mooring had indeed come up and was probably drifting at the surface, which was later confirmed by the Argos satellite transmitter mounted on the top of the string. As a result, the mooring could be recovered successfully on March 3, at 14.00 hours, some 50 nautical miles south of the original mooring site. Subsequent analysis of the data from the CTD sensor mounted on the string conclusively confirmed that the mooring had properly surfaced and had been drifting for about XX hours. Our misjudgement was probably due to a combination of the ship's drift away from the mooring site and acoustical interference, as well as poor reception of the signal from the only answering Benthos release of the two mounted in the bottom frame. The CTD-sensor also provided some useful data on the rate of descent during deployment and the rate of surfacing after release, which amounted to 61 m/min and 50 m/min, thus taking 37 minutes to arrive at the sea floor and 45 minutes to rise to the surface from a bottom depth of 2245 m, respectively (Fig. XXX).

Since both sediment traps in the mooring were pre-programmed to collect until April 10, 2005 (Table XXX), the sampling carrousels would still be at position 23 of 25, so that the large funnel would be 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 was removed and the carrousel manually turned to the open position 25 in order to empty the funnel while retaining sample 23 and sample blank 24 intact, without spilling their poisonous content. Unfortunately, this was not required for the trap in the ASF-bottom frame, as the carrousel appeared not to have rotated at all because the battery power to the motor had been consumed due to a failure in the electronic circuit to shut itself down prior to the first scheduled rotation. Upon arrival on deck, 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 0.95 g l^{-1}) and a pH-buffer ($Na_2B_4O_7{\cdot}10H_2O$; end concentration 1.9 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 the shipboard processing protocol, the sample carrousel was put on top of a newly constructed tightly fitting and stable stand in a deep sink for safe manual rotation of the carrousel and collection of any inadverted leakage of the poisonous supernate solution. The carrousel 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), another 5 ml to fill a PE-pony vial for shipboard analysis of silica, phosphate and ammonia. The remaining about 15 ml was transferred to a 30 ml ZPE bottle for subsequent analysis of density with respect to the ambient seawater. This procedure was repeated until the supernate solution was removed from the connecting neck above each of the 24 sample positions for both trap carrousels, so that all sample bottles could safely be removed from the carrousel, capped, and stored. For the topmost trap on the mooring, which had successfully sampled the settling particle flux at 238 m above the bottom, about 15 ml of the supernate solution was taken from the middle of the sample bottle using an acid-cleaned 20 ml all-PP syringe. About 5 ml was taken to flush the syringe and a syringe-top 0.2 μm Acrodisc filter (into the toxic waste container), and another 5 ml to fill a PE-pony vial for shipboard analysis of silica, phosphate and ammonia. 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 using a calibration curve (Fig. XXX). Subsequently, 50 μl was pipetted from the pony vial and transferred into an acid-cleaned pony vial containing 4900 μl of 1M ultrapure HNO_3 for element analysis by HR-ICP-MS at NIOZ. Conveniently, sample bottle 24 can be taken as a solution blank, as it had not been sampling.

Shipboard analysis of dissolved silica, phosphate and ammonia in the collecting bottles of the topmost sediment trap show strongly enhanced excess concentrations with respect to their blank values (i.e. in the last collecting cup which had not yet opened prior to recovery), due to decomposition of the particulate matter during deployment and prior to shipboard subsampling (Fig. XX1). For ammonia, which largely originates from organic matter decay, particularly high concentrations were measured when residue volumes were largest, e.g. in March 2004, but also for the penultimate collecting cup which had opened 4 days prior to release of the mooring and continued collecting in subsurface waters while drifting for some 14-odd hours prior to recovery. As for phosphate, the latter is obviously due to bacterial decomposition caused by the washing out of the biocide ($HgCl_2$) solution prior to recovery, which is also evidenced by the much lower silica concentration. Such deficient poisoning caused the ammonia concentrations to increase to 1003 μM within a day when subsampled again, confirming that the addition of an extra dose of biocide to was appropriate, as was the doubling of biocide concentrations for the subsequent deployment of the traps (see below). Although virtually all samples showed increased ammonia concentrations when subsampled again next day, this is more likely caused by inorganic decomposition of the organic matter since phosphate concentrations remain about the same. As it seems, the enhanced excess phosphate levels are due to chemical dissolution of highly reactive bio-mineral phases, as they are for dissolved silica which is typically derived from the opaline silica produced by biota such as diatoms, silicoflagellates and radiolarians. However reactivities are apparently higher for phosphates as biogenic silica continued to dissolve, judging from the increased concentration with respect to the measurements on the day before, particularly for the samples collected later in the time-series.

Considering the long collecting intervals of 3 weeks for diffusive loss of the biocide and the occasionally large residues collected, it was decided to provide sample bottles 1 through 23 with an additional 4.9 ml of a saturated solution of $HgCl_2$ (16.03 g on 230 ml of the same trap solution used for the subsequent deployment; see below). This should ensure proper preservation of the particulate matter against biologically mediated decomposition until processing of the sample residues at NIOZ. This 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 (grainsize, foraminifera, dinoflagellates, etc.) and compound specific analysis (biomarkers, $\delta^{15}N$, $\delta^{13}Corg$, etc.).

The sediment trap mooring was redeployed on March 6, 18:13 hours GMT, at 16.419°S, 40.5102°E, just 1.1 nautical miles NNE of the original mooring site and only 2 m shallower in water depth, in order to continue sampling the particle flux in the same sedimentary environment 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 March 9, 2005 at 01:00 UTC, thus ending on September 12, 2006. The same time-series sediment traps were used, i.e. two Technicap PPS-5/2s with a collecting area of 1.0 m^2 and a 1.5 cm honeycomb baffle. The electronic prints in the previously failing motor were replaced, tested and short circuited where necessary in order to ensure proper rotation during subsequent deployment of both traps. Also the OBS sensor in the sensor package on the bottom trap was replaced by a new and much more sensitive one, and the measurement interval was increased to 15 minutes in order to retrieve a complete data set for the entire deployment period. Sample cups were filled with seawater collected at the deployment depth of each trap, in which a biocide (16 g of $HgCl_2$; end-concentration 1.77 g l^{-1}) and a pH-buffer (16 g of $Na_2B_4O_7{\cdot}10H_2O$; end concentration 1.76 g l^{-1}) were dissolved, supplemented by milliQ-water (800 ml on 8.0 l of seawater) to a density slightly in excess of the ambient seawater. Consequently, a higher concentration of biocide was used than previously to ensure complete preservation against bacterial decomposition during the prolonged collecting time. 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 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 bottles with known weights of cultured diatoms, biogenic silica, inorganic opaline silica and a silica gel were mounted on the traps to assess in-situ silica dissolution in the same trap solution with respect to the intercepted flux. Furthermore a passive sampler cage with the same materials was mounted on the bottom frame some 40 cm from the sea floor for the same purpose (see above).

5 Multicore geochemistry and biogenic silica dissolution 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, five multicore stations were sampled along the mooring transect in the Mozambique Channel, to partly repeat and supplement the stations sampled in 2003. The positions of the multicore stations, water depth and sediment recovery are listed below.

Station #	Water depth (m)	Pos. latitude	Pos. longitude	Bottom water Temp. (ºC)	Sediment recovery
MC1	1035	16º 31.06 S	40º 01.00 E	6.3	Good
MC2	2484	16º 42.24 S	40º 51.42 E	2.2	Good
MC3	2720	16º 47.36 S	41º 08.36 E	2.1	Good
MC4	1980	16º 36.00 S	40º 26.12 E	2.5	Good
MC5	2695	16º 52.18 S	41º 29.30 E	2.1	Good

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. For pore water extraction, four 6cm-id cores were sliced using a high-precision hydraulic slicer that positions up to four cores simultaneously. Cores were sliced in 0.25cm slices for the 0-1cm depth interval, in 0.5cm slices for the 1-3cm depth interval, in 1 cm slices for the 3-7cm depth interval and in 2cm slices below 7cm depth. For each depth interval, sediment slices were pooled and centrifuged for 10 minutes at 3000 rpm to extract the pore water. The extracted pore waters were filtered through 0.45µm Acrodisc filters and analysed onboard ship for dissolved silicate, total nitrate, ammonium and phosphate. Samples for dissolved inorganic carbon and ICP-MS were collected onboard and will be analysed at home.

From the other 4 6cm-diameter cores, sediment samples were collected for porosity. The solid phase retrieved after pore water extraction will be sampled for organic carbon and nitrogen at intervals corresponding with those samples for the pore waters. Furthermore, the solid phase will be sampled at 0-0.5, 0.5-1, 1-2, 2-3, 4-6 and 13-17cm depth intervals to be analysed for ^{234}Thorium.

Two or three 10cm-diameter cores were transferred to the cold lab upon arrival on deck. The cores were sampled at 3-hour intervals for 15 hrs. to determine the flux of dissolved silicate, total nitrate, ammonium and phosphate across the sediment-water interface.

Biogenic silica dissolution experiments

To study dissolution of biogenic silica as a function of pressure, dissolution cages were deployed on the mooring lines. Semi –permeable membrane tubing (Spectrapor) was filled with two natural biogenic silica samples (fresh, cultured diatom *Thalassiosira punctigera*) and 3 types of artificial silica (silicagel 60, aerosil 50 and aerosil 200). The pieces of membrane were stretched between the top and bottom of the cage, surrounded by a stainless steel protective grid. 7 cages were deployed on the mooring lines at 150, 250, 500, 1000, 1500, 2000 and 2500m water depth, while the last cage was fixed to the bottom sediment trap (figure 1, purple triangles). After recovery of the moorings, the weight loss of the respective samples will give information on the pressure dependency of the biogenic silica dissolution rates.

6 Pistoncores: techniques and the down-core record

During the cruise 4 pistoncores were taken, 3 with a 12 m and one with an18 m core barrel, all with liners of 11 cm in diameter, using a NIOZ designed pistoncore system. All coring sites were situated on the mooring transect at the western side of the Mozambique Channel. From the top of the slope towards the deep channel cores D289-02, D289-25, D289-15 (on the mooring site of the sediment trap) and D289-10 were retrieved with a recovery of 9.21 m, 8.02 m, 8.35 m and 6.67 m, respectively. Pistoncore D289-25 is missing a considerable part of the upper sediment layers because the liner imploded in the core barrel. In conjunction with the pistoncore, a tripcore was recovered from all stations, except for D289-10. At all sites one or two of the subcores collected by the Multicorer at the same position was taken to collect the topmost part of the sediment column, which is usually missing from the pistoncore itself. Pistoncores were cut in 1 m sections but otherwise remained closed during the cruise, as were all other cores, and will only be opened for core-scanning and description at NIOZ. After measurement the cores were stored a constant temperature of 4 °C for cooled container transport to NIOZ.

When possible subsamples were taken from the tripcore and the corehead, which were sieved for a first order qualitative assessment of their particle composition, specifically their foraminiferal content. In addition, a subsample of every section was taken from core D289-25. The presence or absence of the planktonic foraminifer *Globigerinoides ruber* “pink” was taken to determine whether or not the sediment was older or younger than 120.000 years, respectively, when this species became extinct in the Indo-Pacific. This showed that all sediments collected from the pistoncore heads were older than 120.000 year, as were the lower 4 sections of pistoncore D289-25. However, all tripcores, the bottom of all Multicores and the upper 3 sections of pistoncore D289-25 contained sediments younger than 120.000 year.

Magnetic susceptibility was measured shipboard on all pistoncores using a Bartington MS2C sensor. Cores were moved through the sensor and measured in steps of two centimeters, making an blank measurement every meter, i.e. compatible with the section length. Drift corrections and core diameter corrections have been applied automatically within in the Multisus program, and all data were stored digitally (Fig. 11).

Core D289-02 was taken at the shallowest part of the channel at a depth of 928m and shows a magnetic susceptibility profile that differs markedly from the cores taken deeper on the channel margin. Two peaks can be observed in the profile, i.e. at the top and at the bottom of the core. Sampling of the deepest part of the core shows that the high susceptibility at the bottom corresponds to coarse grained, probably winnowed foraminiferal sands older than 120.000 years. The cores taken deeper down the channel margin all show highly variable magnetic susceptibility. Cores taken and described during a Meteor cruise off the Zambezi, just a few weeks earlier show the presence of sediment flows and turbidites (R. Schneider, Univ. Kiel, pers. comm.), which may well be related to the variability we observed in the magnetic susceptibility profiles. Correlation between the cores was not possible because of the large distance between the coring sites both in the Mozambique Channel and off the Zambezi.

station	**depth (m)**	**Position**		**date**	**core length (m)**	**remarks**
D289-2pc	928	16.51333	40.02833	3 March 2005	9.21	ok
D289-10pc	2345	16.69667	40.85667	4 March 2005	8.35	ok
D289-15pc	2687	16.79167	41.135	5 March 2005	6.67	ok
D289-25pc	1980	16.58667	40.43167	7 March 2005	8.02	top missing

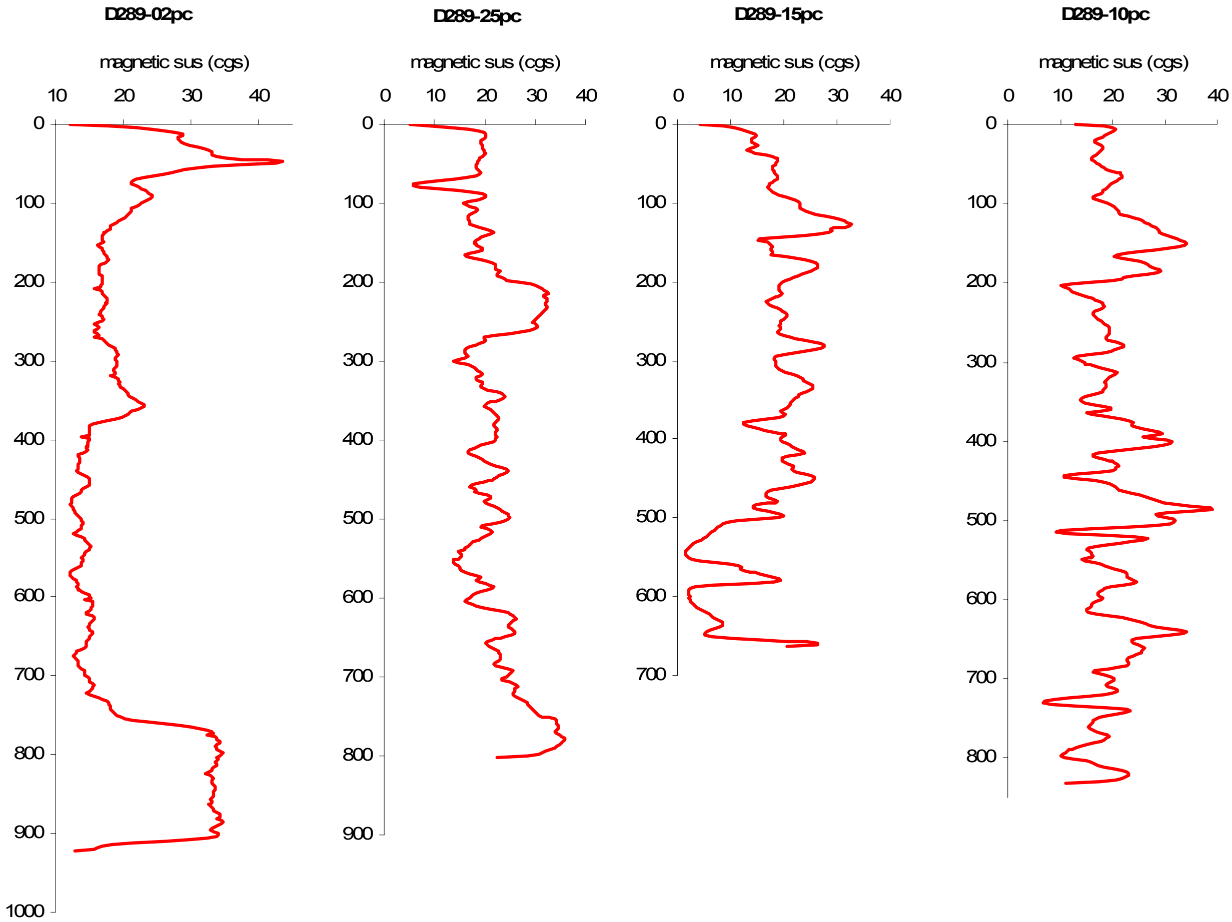


Figure 11. Magnetic susceptibility profiles of pistoncores taken during cruise D289 in the Mozambique Channel. Profiles are arranged according to depth.

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Appendix A

cruise summary (*.SUM file) of RRS Discovery cruise 64D289B

Cruise Summary Discovery D289, 2005

Cast types and Parameters may be added from the "codes" sheet

Cast types:	abbr.
CTD+SBE37	CTD+SBE37
CTD+samples	CTD+samples
Pistoncore	PC
Multicore	mc
Mooring deployment	md
Mooring recovery	mr

Event codes:	abbr.
begin	be
bottom	bo
end = on board	end
grappled	gr
top on board	top

EXPOCODE	Station	Type	Event	date (dd/mmm/yyyy)	UTC time	latitude degr	latitude min.decmin	longitude degr	longitude min.decmin	cast Depth	Comments	CTD file name (.dat)	nuts file name
D289	001	CTD+samples	be	02/Mar/2005	17:36	16	34.5	40	8.0		no NMEA available	D289001	CTD050302AR1.xls
D289	001	CTD+samples	bo	02/Mar/2005	18:12	16	34.5	40	8.0	1395			
D289	001	CTD+samples	end	02/Mar/2005	19:27	16	34.3	40	8.2				
D289	002	mc	be	02/Mar/2005	21:46	16	31.0	40	0.8				
D289	002	mc	bo	02/Mar/2005	22:14	16	31.1	40	1.0	1035			
D289	002	mc	end	02/Mar/2005	22:42	16	31.2	40	1.2				
D289	003	pc	be	02/Mar/2005	23:05	16	31.2	40	1.3				
D289	003	pc	bo	03/Mar/2005	00:00	16	30.8	40	1.7	928			
D289	003	pc	end	03/Mar/2005	00:55	16	30.3	40	2.2				
D289	004	mr	be	03/Mar/2005	03:15	16	32.8	40	8.8		LMC4 released		
	004	mr	gr	03/Mar/2005	03:47	16	32.5	40	9.1				
D289	004	mr	end	03/Mar/2005	04:21	16	32.5	40	8.8		LMC4 on board		
D289	005	CTD+samples	be	03/Mar/2005	08:50	16	37.9	40	37.2		no NMEA available	D289002	CTD050302AR1.xls

D289	005	CTD+samples	bo	03/Mar/2005	09:33	16	37.6	40	37.2	1975	bottle 2 leaked		
D289	005	CTD+samples	end	03/Mar/2005	10:48	16	37.2	40	37.4				
D289	006	mr	be	03/Mar/2005	11:08	16	38.1	40	36.4		LMC5 released		
	006	mr	top	03/Mar/2005	23:50	16	38.4	40	36.2				
D289	006	mr	end	03/Mar/2005	12:48	16	38.5	40	36.0		mooring LMC5 on board		
D289	007	mr	be	03/Mar/2005	15:23	16	42.6	40	50.7		trap-mooring released, but trap still on bottom		
D289	008	CTD+samples	be	03/Mar/2005	18:57	16	45.6	41	2.7		no NMEA available	D289003	CTD050304AR1.xls
D289	008	CTD+samples	bo	03/Mar/2005	19:45	16	45.2	41	2.4	2360			
D289	008	CTD+samples	end	03/Mar/2005	21:10	16	44.8	41	2.3				
D289	009	mc	be	03/Mar/2005	23:30	16	42.7	40	52.3				
D289	009	mc	bo	04/Mar/2005	00:50	16	42.4	40	51.7	2484			
D289	009	mc	end	04/Mar/2005	01:45	16	42.3	40	51.6				
D289	010	pc	be	04/Mar/2005	02:22	16	42.0	40	51.5				
D289	010	pc	bo	04/Mar/2005	03:22	16	41.8	40	51.4	2345			
D289	010	pc	end	04/Mar/2005	04:40	16	41.5	40	51.3				
D289	011	mr	be	04/Mar/2005	07:10	16	45.8	41	3.3		LMC5A released		
	011	mr	gr	04/Mar/2005	07:25	16	45.8	41	3.3				
D289	011	mr	end	04/Mar/2005	09:30	16	44.0	41	2.0		LMC5A on board		
D289	012	mr	gr	04/Mar/2005	14:02	16	28.7	40	32.7		trap recovery		
D289	012	mr	end	04/Mar/2005	16:00	16	26.1	40	32.5				
D289	013	CTD+samples	be	04/Mar/2005	19:48	16	42.6	40	50.8			D289004	CTD050305AR1.xls
D289	013	CTD+samples	bo	04/Mar/2005	20:36	16	42.2	40	50.6	2221			
D289	013	CTD+samples	end	04/Mar/2005	21:54	16	41.7	40	50.7				
D289	014	mc	be	05/Mar/2005	00:48	16	47.7	41	7.9				
D289	014	mc	bo	05/Mar/2005	01:57	16	47.6	41	8.2	2720			
D289	014	mc	end	05/Mar/2005	02:55	16	47.6	41	8.3				
D289	015	pc	be	05/Mar/2005	03:08	16	47.6	41	8.3				
D289	015	pc	bo	05/Mar/2005	04:28	16	47.5	41	8.1	2687			
D289	015	pc	end	05/Mar/2005	05:37	16	47.6	41	7.9				

D289	016	mr	be	05/Mar/2005	08:23	16	52.1	41	28.2		LMC6 released		
	016	mr	gr	05/Mar/2005	08:40	16	52.1	41	28.5				
D289	016	mr	end	05/Mar/2005	10:25	16	51.8	41	28.4		LMC6 on board		
D289	017	CTD	be	05/Mar/2005	12:25	16	49.2	41	16.2		test L-ADCP	testing	
D289	017	CTD	bo	05/Mar/2005	12:45	16	49.3	41	16.0	1000			
D289	017	CTD	end	05/Mar/2005	13:05	16	49.4	41	15.8				
D289	018	CTD+samples	be	05/Mar/2005	13:35	16	49.8	41	15.5			D289005	CTD050306BR1.xls
D289	018	CTD+samples	bo	05/Mar/2005	14:30	16	49.6	41	15.2	2630			
D289	018	CTD+samples	end	05/Mar/2005	15:53	16	49.3	41	14.7				
D289	019	CTD+SBE37	be	05/Mar/2005	18:15	16	50.1	41	16.1		no L-ADCP data available	D289006	xxxxxxxxxxxxxxx
D289	019	CTD+SBE37	bo	05/Mar/2005	19:15	16	50.3	41	15.5	2600	downcast 60 sec/100 mtr halted		
D289	019	CTD+SBE37	end	05/Mar/2005	20:27	16	50.5	41	15.4		no bottles filled		
D289	***020***	***md***	***be***	***06/Mar/2005***	***04:46***	***16***	***30.2***	***40***	***9.5***		***LMC4 deployment***		
D289	***020***	***md***	***end***	***06/Mar/2005***	***06:18***	***16***	***32.56***	***40***	***8.96***		***mooring released***		
D289	021	CTD+SBE37	be	06/Mar/2005	08:26	16	35.7	40	22.6		upcast 60 sec/100 mtr halted	D289007	CTD050306BR1.xls
D289	021	CTD+SBE37	bo	06/Mar/2005	09:10	16	35.4	40	22.6	1695			
D289	021	CTD+SBE37	end	06/Mar/2005	10:30	16	35.1	40	22.7				
D289	***022***	***md***	***be***	***06/Mar/2005***	***13:00***	***16***	***36.7***	***40***	***36.2***		***LMC5 deployment***		
D289	***022***	***md***	***end***	***06/Mar/2005***	***14:10***	***16***	***38.78***	***40***	***36.75***		***mooring released***		
D289	***023***	***md***	***be***	***06/Mar/2005***	***16:38***	***16***	***41.10***	***40***	***51.10***		***trap deployment***		
D289	***023***	***md***	***end***	***06/Mar/2005***	***18:13***	***16***	***41.9***	***40***	***51.02***		***trap released 2240 mtr***		
D289	024	mc	be	07/Mar/2005	21:07	16	36.5	40	26.6				
D289	024	mc	bo	07/Mar/2005	22:05	16	36.0	40	26.2	1980			
D289	024	mc	end	07/Mar/2005	22:36	16	35.5	40	26.1				
D289	025	pc	be	07/Mar/2005	23:10	16	35.3	40	26.0				
D289	025	pc	bo	07/Mar/2005	00:00	16	35.2	40	25.9	1980			
D289	025	pc	end	07/Mar/2005	01:10	16	34.8	40	25.7				
D289	026	***md***	***be***	07/Mar/2005	06:55	16	43.3	41	3.5		***LMC5A deployment***		
D289	026	***md***	***end***	07/Mar/2005	09:16	16	45.7	41	3.9	2403	***mooring released***		

D289	027	***md***	***be***	07/Mar/2005	13:15	16	52.1	41	25.6		***LMC6 deployment***		
D289	027	***md***	***end***	07/Mar/2005	15:10	16	52.28	41	28.56		***mooring released***		
D289	028	CTD+samples	be	07/Mar/2005	15:33	16	52.30	41	29.61			D289008	CTD050308AR1.xls
D289	028	CTD+samples	bo	07/Mar/2005	16:27	16	52.7	41	29.3	2695			
D289	028	CTD+samples	end	07/Mar/2005	17:56	16	53.4	41	28.9				
D289	029	mc	be	07/Mar/2005	19:04	16	52.3	41	29.5				
D289	029	mc	bo	07/Mar/2005	20:09	16	52.7	41	29.0	2986			
D289	029	mc	end	07/Mar/2005	21:01	16	53.0	41	28.5				
D289	030	mr	be	09/Mar/2005	12:30	17	5.9	42	28.8		LMC8 released		
D289	030	mr	gr	09/Mar/2005	12:58	17	6.3	42	28.9				
D289	030	mr	end	09/Mar/2005	14:02	17	5.4	42	29.2		LMC8 recovered		
D289	031	CTD+samples	be	09/Mar/2005	14:45	17	5.7	42	29.5			D289009	CTD050310AR1.xls
D289	031	CTD+samples	bo	09/Mar/2005	15:28	17	6.0	42	29.7	2160			
D289	031	CTD+samples	end	09/Mar/2005	16:47	17	6.3	42	30.0				
D289	032	CTD+samples	be	09/Mar/2005	20:17	17	14.5	43	1.1			D289010	CTD050310AR1.xls
D289	032	CTD+samples	bo	09/Mar/2005	20:53	17	14.3	43	0.8	1520			
D289	032	CTD+samples	end	09/Mar/2005	21:50	17	14.3	43	0.4				
D289	033	mr	gr	10/Mar/2005	03:22	17	15.0	43	1.9				
D289	033	mr	end	10/Mar/2005	03:58	17	14.7	43	1.1		LMC9 recovered		
D289	***034***	***md***	***be***	***10/Mar/2005***	***04:54***	***17***	***16.3***	***43***	***2.7***		***LMC9 deployment***		
D289	***034***	***md***	***end***	***10/Mar/2005***	***06:04***	***17***	***14.78***	***43***	***2.47***	***1428***	***mooring released***		
D289	35	CTD+SBE37	be	10/Mar/2005	08:11	17	10.3	42	45.4		upcast 60 sec/100 mtr halted	D289011	CTD050310BR1.xls
D289	35	CTD+SBE37	bo	10/Mar/2005	08:52	17	10.2	42	45.3	1890			
D289	35	CTD+SBE37	end	10/Mar/2005	10:28	17	10.4	42	45.1				
D289	***36***	***md***	***be***	***10/Mar/2005***	***12:35***	***17***	***8.7***	***42***	***30.3***		***LMC8 deployment***		
D289	***36***	***md***	***end***	***10/Mar/2005***	***14:16***	***17***	***6.54***	***42***	***28.82***	***2199***	***mooring released***		
D289	37	CTD+samples	be	10/Mar/2005	16:35	17	2.5	42	12.4			D289012	CTD050311AR1.xls
D289	37	CTD+samples	bo	10/Mar/2005	17:20	17	3.0	42	12.4	2130			
D289	37	CTD+samples	end	10/Mar/2005	18:29	17	3.4	42	12.4				

D289	38	CTD+SBE37	be	10/Mar/2005	20:48	16	58.8	41	57.7		upcast 60 sec/100 mtr halted	D289013	CTD050311AR1.xls
D289	38	CTD+SBE37	bo	10/Mar/2005	21:36	16	59.2	41	52.8				
D289	38	CTD+SBE37	end	10/Mar/2005	23:05	16	59.6	41	57.6				
D289	39	mr	be	10/Mar/2005	03:06	16	58.9	41	56.5		LMC7 released		
D289	39	mr	gr	10/Mar/2005	03:25	16	58.8	41	56.4				
D289	39	mr	end	10/Mar/2005	04:09	16	58.1	41	55.8		LMC7 recovered		
D289	***40***	***md***	***be***	***10/Mar/2005***	***04:53***	***16***	***59.9***	***41***	***57.1***		***LMC7 deployment***		
D289	***40***	***md***	***end***	***10/Mar/2005***	***05:46***	***16***	***58.87***	***41***	***56.49***	***???***	***mooring released***		

Appendix B

Mooring information file of Pelagia cruise 64D289B

Mooring ID	Location of deployment: Latitude deg S	Latitude min S	Longitude deg E	Longitude min E	Water depth	measurement Type	instrument Type	Instrument ID	meters below surface	Recording interval(s)	DSU No.	Start date	Start time(UTC)	Deployment date	Deployment time	Oceano AR-861 releases Nr.	code	Argos buoy ID/SN	Argos code
LMC4	16	32.7	40	9.0	1350	ADCP	LR	3439	591	1800		06-Mar	05:00	6-Mar	6:18	154	04c9	CML 60669	23495
						CTD	SBE-37-SM	3623	625	300		06-Mar	04:00			155	04ca		
						CTD	SBE-37-SM	3622	1075	300		06-Mar	04:00						
						ADCP	LR	3549	1340	1800		06-Mar	05:00						
LMC 5	16	38.8	40	36.8	1992	ADCP	LR	3552	591	1800		06-Mar	12:30	6-Mar	14:10	162	04D2	CML 60670	22621
						CTD	SBE-37-SM	2659	625	300		06-Mar	10:00			163	04D3		
						currentmeter	RCM9	350	991	900	7325								
						CTD	SBE-37-SM	2652	1025	300		06-Mar	10:00						
						currentmeter	RCM11	44	1491	900	8132								
						CTD	SBE-37-SM	2650	1525	300		06-Mar	10:00						
						CTD	SBE-37-SM	2654	1975	300		06-Mar	10:00						
						ADCP	LR	3702	1995	1800		06-Mar	12:30						
LMC5 A	16	45.7	41	3.9	2403	CTD	SBE-37-SM	2655	110	300		07-Mar	07:00	7-Mar	9:16	152	04C7	CML 60668	22312
						dissolution cage		1	115										
						CTD	SBE-37-SM	2656	200	300		07-Mar	07:00			153	04C8		
						dissolution cage		2	205										
						CTD	SBE-37-SM	2657	400	300		07-Mar	07:00						
						dissolution cage		3	405										
						currentmeter	RCM9	341	481	900	7030								
						dissolution cage		4	985										
						currentmeter	RCM11	48	992	900	8728	06-	17:01						

												Mar							
						dissolution cage		5	1480										
						currentmeter	RCM11	49	1491	900	8128								
						CTD	SBE-37-SM	2649	1525	300									
						dissolution cage		6	1480										
						CTD	SBE-37-SM	2651	1975	300									
						CTD	SBE-37-SM	2653	2375	300									
						ADCP	LR	3701	2391	1800									

Mooring	Location of deployment Latitude		Longitude		Water	measurement	instrument	Instrument	meters below	Recording		Start	Start	Deployment		Oceano AR-861 releases		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
LMC6	16	52.3	41	28.6	2692	ADCP	LR	1431	591	1800		06-Mar	12:00	7-Mar	15:10	150	04C5	CML 60661	22429
						CTD	SBE-37-SM	3988	625	300						151	04C6		
						currentmeter	RCM9	411	991	900	13145								
						CTD	SBE-37-SM	2663	1025	300									
						currentmeter	RCM11	130	1491	900	11800	06-Mar	16:59						
						CTD	SBE-37-SM	2664	1975	300									
						CTD	SBE-37-SM	2665	2375	300									
						dissolution cage		7	2500										
						ADCP	LR	3596	2689	1800									
						CTD	SBE-37-SM	2666	2675	300									
LMC7	16	58.9	41	56.5	1995	ADCP	LR	3440	621	1800		11-Mar	05:00	####	5:46	156	04CB	CML 60671	23490

						CTD	SBE-37-SM	3624	650	300						157	04CC		
						currentmeter	RCM11	200	992	900									
						currentmeter	RCM11	202	1491	900									
						CTD	SBE-37-SM	2658	1525	300									
LMC8	17	6.5	42	28.8	2199	ADCP	LR	3641	596	1800				####	14:16	158	04CD	CML 69021	25382
						CTD	SBE-37-SM	2668	625	300						159	04CE		
						currentmeter	RCM11	35	994	900	12232	06-Mar	16:57						
						CTD	SBE-37-SM	2669	1025	300									
						currentmeter	RCM11	205	1493		13744	06-Mar	17:50:00						
						CTD	SBE-37-SM	2670	2075	300									
						currentmeter	RCM11	240	2092		13526	06-Mar	17:53:40						
LMC9	17	14.8	43	2.5	1428	currentmeter	RCM11	132	628	900	12231	06-Mar	17:02	####	6:04	160	04CF	CML 60672	23201
						currentmeter	RCM11	45	1026	900	12091	06-Mar	16:50			161	04D1		
trap	16	41.9	40	51.0	2240	currentmeter	RCM11	123	1950	900				6-Mar	18:13	Benthos		ID1770	SN12074
						trap		51	2011										
						currentmeter	RCM11	36	1950	900									
						CTD	SBE-37-SM	2661	2200	300						949	D/B	MDL3721	
						trap	PPS5	09-Jun	2245										
						dissolution cage		8	2245										

Appendix C

Rotation schedule sediment traps

Mooring MOZ-2: deployed Sunday March 6, 2005 at 18:13 GMT during LOCO/D289 (EL LOCO)

prospective recovery by November, 2006 by ???

all dates and times in UTC **position:** **16 deg 42.82S, 40 deg 51.13E**

position number	date UTC dd-m-yy hr:min	sampling	date UTC dd-m-yy hr:min	Collecting interval (days)	bottle number
0	9-3-2005 1:00	start sample #1	9-mrt-05 01:00	**programmed as if 1994**	
1	1-4-2005 1:00	start sample #2	1-apr-05 01:00	**23**	**MOZ-2-A/B-1**
2	24-4-2005 1:00	start sample #3	24-apr-05 01:00	**23**	**MOZ-2-A/B-2**
3	17-5-2005 1:00	start sample #4	17-mei-05 01:00	**23**	**MOZ-2-A/B-3**
4	9-6-2005 1:00	start sample #5	9-jun-05 01:00	**23**	**MOZ-2-A/B-4**
5	2-7-2005 1:00	start sample #6	2-jul-05 01:00	**23**	**MOZ-2-A/B-5**
6	25-7-2005 1:00	start sample #7	25-jul-05 01:00	**23**	**MOZ-2-A/B-6**
7	17-8-2005 1:00	start sample #8	17-aug-05 01:00	**23**	**MOZ-2-A/B-7**
8	9-9-2005 1:00	start sample #9	9-sep-05 01:00	**23**	**MOZ-2-A/B-8**
9	2-10-2005 1:00	start sample #10	2-okt-05 01:00	**23**	**MOZ-2-A/B-9**
10	25-10-2005 1:00	start sample #11	25-okt-05 01:00	**23**	**MOZ-2-A/B-10**
11	17-11-2005 1:00	start sample #12	17-nov-05 01:00	**23**	**MOZ-2-A/B-11**
12	10-12-2005 1:00	start sample #13	10-dec-05 01:00	**23**	**MOZ-2-A/B-12**
13	2-1-2006 1:00	start sample #14	2-jan-06 01:00	**23**	**MOZ-2-A/B-13**
14	25-1-2006 1:00	start sample #15	25-jan-06 01:00	**23**	**MOZ-2-A/B-14**
15	17-2-2006 1:00	start sample #16	17-feb-06 01:00	**23**	**MOZ-2-A/B-15**
16	12-3-2006 1:00	start sample #17	12-mrt-06 01:00	**23**	**MOZ-2-A/B-16**
17	4-4-2006 1:00	start sample #18	4-apr-06 01:00	**23**	**MOZ-2-A/B-17**
18	27-4-2006 1:00	start sample #19	27-apr-06 01:00	**23**	**MOZ-2-A/B-18**
19	20-5-2006 1:00	start sample #20	20-mei-06 01:00	**23**	**MOZ-2-A/B-19**
20	12-6-2006 1:00	start sample #21	12-jun-06 01:00	**23**	**MOZ-2-A/B-20**
21	5-7-2006 1:00	start sample #22	5-jul-06 01:00	**23**	**MOZ-2-A/B-21**
22	28-7-2006 1:00	start sample #23	28-jul-06 01:00	**23**	**MOZ-2-A/B-22**
23	20-8-2006 1:00	start sample #24	20-aug-06 01:00	**23**	**MOZ-2-A/B-23**
24	12-9-2006 1:00	end sample #24	12-sep-06 01:00	**23**	**MOZ-2-A/B-24**