Cruise Report

LOCO-IW03

cruise LOCO03-Canary Basin

R.V. Pelagia cruise 64PE208

06-19 March, 2003

20 March 2003

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(with contributions from participants)

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0. Contents

1. Summary of R.V. Pelagia LOCO-IW03 cruise

BoBO, contam, DOC,XCP

Between mid-July and early September 2002 the R.V. Pelagia (NIOZ, The Netherlands) sailed twice to the Rockall Channel, mainly to deploy and recover moorings within 'ROCS'. ROCS is a NIOZ-funded project. It is a multidisciplinary oceanographic study (involving marine physicists and chemists) on the interaction between bottom topography and internal ocean currents. Specifically we study sudden transitions in bottom boundary layer currents and effects on fluxes of suspended material.

The working area of ROCS was the foot of the continental slope in the Rockall Channel near 54° 10' N, 14° 00' W (~2900 m depth). Four moorings were deployed at mutual distances of about 10 km. One mooring was on the 8% bottom slope, the others 5 or 10 km away from the abrupt change to the abyssal plain. These moorings ranged 50-100 m above the bottom and sampled during 45 days. One moorings held fast-sampling instruments: ADCP sampling at once per 15 s and a NIOZ built fast and accurate thermistor string sampling at once per 4 s. The other three consisted of 4 current meters sampling once per 2 minutes and 2 sediment traps sampling every 2-4 days. During the deployment cruise a single CTD-transect mapped the backgrouns hydrography perpendicular to the continental slope. For the interpretation of suspended sediment sampling, some benthic sedimentological sampling was performed.

In general, the cruise was successful. This success was achieved because of the experienced crew and participants on board. Weather conditions were good. Most instruments worked flawlessly, with some problems occurring in acoustic (current) measurements attributable to the clearness of the water at some depths in terms of (the lack of) appropriate scatterers. Preliminary results show strong zonation of benthos and sedimentation along the slope. The benthos sampling and the novel fykes mounted on the sediment trap frames moored at the bottom gave high quality information on the variations in the benthic community. The sedimentation is found to vary in amplitude and in time across the slope. In addition, the timing of maximum sedimentation varies across the slope. Like during the 1997 pilot study, strong fronts are encountered, occurring more vigorously than before. These fronts are associated with strong near-bottom flow accelerations, temperature variations and bursts of (re)suspended material, occurring on time scales of minutes. The strong zonation and sedimentation variations above the slope are reflected in the enhanced turbulence dissipation rates found above the central part of the slope and the strong variations (with time) of the density stratification. This variability seems associated with (internal) tidal wave. Internal wave motions seem less important in the interior of the channel, but this requires further data analysis.

2. General research summary.

LOCO

The N.W.O.-financed large investement programme Long-term Ocean-Climate Observations (LOCO) aims to carry out some regional experiments which are required for the development of an ocean observation system for CLIVAR and other related global monitoring programmes. The instruments will be used to obtain long-term observations of the current field and transport of heat and fresh water in some critical areas of the global ocean circulation and of processes in the ocean interior providing energy for diapycnal mixing, for example due to internal waves, a key parameter in controlling the large scale circulation. In order to observe low-frequency variations these moorings will be deployed for periods of at least 3 to 7 years, so that also variations due to the El-Niño cycle and the North Atlantic Oscillation may be covered. The experiments with moored sub-surface measuring systems build upon previous WOCE (World Ocean Circulation Experiment) and CLIVAR projects, carried out by Dutch oceanographers. It will extend existing time series and/or monitoring programmes and will be carried out in the framework of internationally coordinated research programmes.

LOCO-IW

Within LOCO two sets of four moorings will be used to study in more detail the climatological mean of spatial and temporal variability of internal-wave intensity. This will be done for different types of basins (above sloping topography and far away from boundaries in deep-ocean basins). The first set of these moorings will be located for medium-long periods (~1½ years) at mid-latitudes in the North Atlantic Ocean, and the second set near the LOCO-throughflow sites in the Irminger Basin and the Mozambique Channel to study specific processes like internal wave focusing and effects of convection. Together these sites are exemplary for most internal wave appearances.

LOCO-IW Canary Basin

The purpose of the LOCO-IW03 cruise is to study the climatologic effects of internal waves on the deep-ocean. Specifically, we study near-inertial internal motions generated by atmospheric disturbances and those by diurnal tides (~30° N). During the cruise four moorings will be deployed extending 3.7 km above the bottom (1.5 km below the sea surface). These moorings will contain current meters and temperature sensors. They will remain in position for 1.5 years. In addition, short-term hydrographic and mixing information will be collected using CTD, XCP and LADCP in the vicinity of the moorings.

3. LOCO-IW03 aim and site.

Internal wave mixing is thought to be the key in maintaining the general ocean circulation, induced about half by tidal motions and half by atmospheric (wind) induced inertial motions. As waves do not mix, non-linear interaction between internal waves is assumed to transfer energy to smaller scales, eventually leading to wave breaking, and mixing. Near-inertial internal waves are considered to be important because of their strong shear, tidal motions because of persistent generation and focusing in basins. Recent observations over the abyssal plain in the Bay of Biscay (van Haren et al., 2002) suggest that non-linear interaction between internal waves occurs not only in topographically-dominated areas, but, due to the presence of strong, deep-ocean near-inertial motions, also well away from sloping boundaries. During this first cruise of LOCO the aim is on studying the slow (O(months)) variability with time of deep-ocean near-inertial and internal tidal motions in an area where deterministic (diurnal tidal) forcing of near-inertial motions may be important.

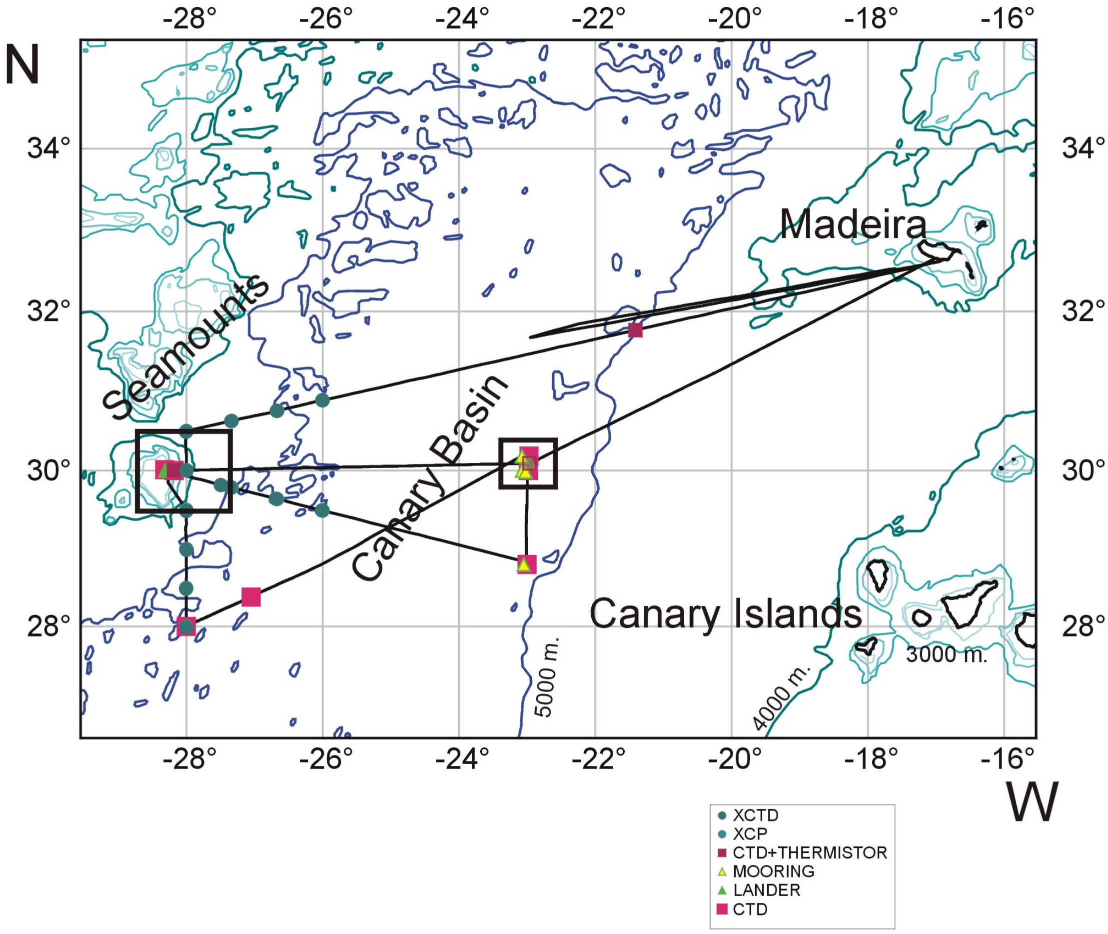
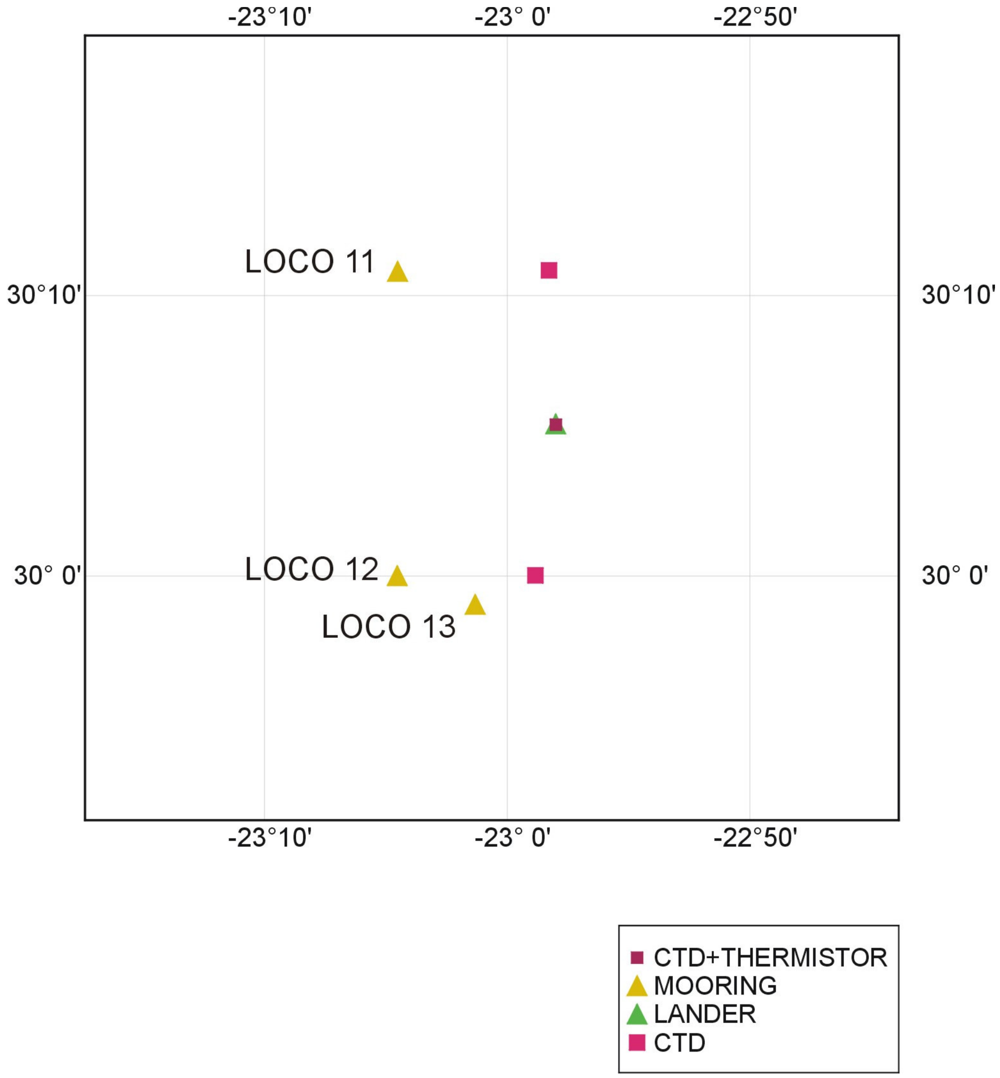


Fig. 1. Map of the LOCO-IW site and cruise track.



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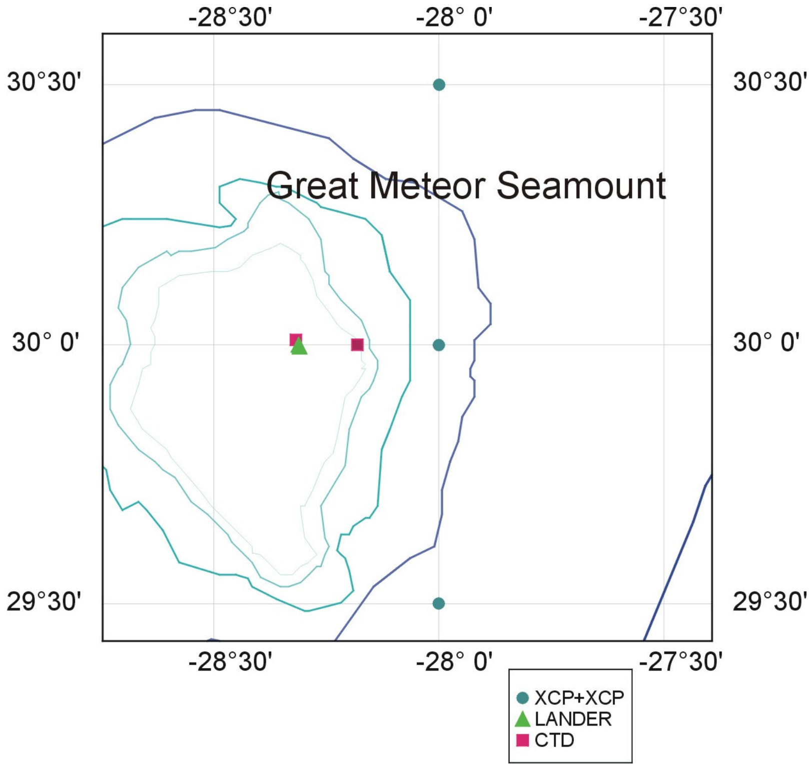

Fig. 1. Map of the LOCO-IW site and cruise track.

LOCO-IW moorings

Four closely spaced (5-100 km) and long (~3.7 km) moorings were deployed near 30ºN, 23°W in the Canary Basin (~5 km deep) halfway between the continental slope and seamounts of the Mid-Atlantic Ridge (Fig. 1). Later in LOCO this set of moorings will also be located at a position above rough topography (the nearby Mid-Atlantic Ridge), where mixing due to internal waves is known to be relatively strong.

Table 1. Proposed mooring latitudes (near 23°W) and corresponding local inertial (harmonic tidal) frequencies

LOCO11	30.18082°(30°10.849')N	1.008214 cpd (φ_1)
DOC03-2	30.09037°(30°05.421')N	1.005476 cpd (ψ_1) mixBB bottomlander
LOCO12	30.00000°(30°00.000')N	1.002738 cpd (K_1)
LOCO13	29.98225°(29°58.935')N	1.002200 cpd
LOCO14	28.79973°(28°47.984')N	0.966137 cpd (M_1)

As the aim is to study diurnal tidal and inertial internal wave motions, the moorings will be located sharply at and very close to 30ºN to establish near-inertial internal wave propagation directions (Table 1). Some of the latitudinal distances between moorings are less than one mooring length (between moorings LOCO12 and LOCO13). Others correspond to theory on down- and poleward propagation of near-inertial waves focusing (Maas, 2001; ~10

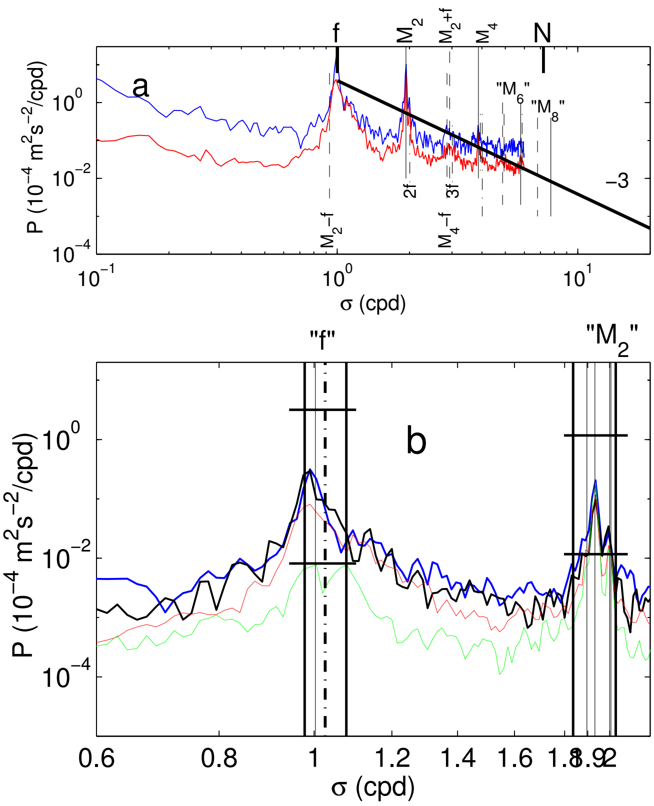

Fig. 2.Kinetic energy spectra at 30.0233°N, 24°W deployed by IfM Kiel in 1988. a. 300 days data from 141 (blue), 1100 m (red). b. 200 days data from 141(blue), 246(black),1100(red),5175 m(green). Near f vertical lines are at .97f, f, 1.023f(dashed),1.07f.

km, between moorings LOCO11, DOC03-1 and LOCO12) being less than theoretical predictions on near-inertial wave propagation from the surface down- and equatorward (Garrett, 2001; ~300 km). The latter theory seems an overestimate as the same theory predicts a shift of 9% in inertial frequency between the surface and the bottom, whilst preliminary analysis on data from IfM Kiel (Siedler and Paul, 1991) shows frequency shifts over the vertical being much less than this (Fig. 2).

For practical reasons (mooring deployment and recovery) and for proper horizontal spatial coverage the moorings LOCO12 and LOCO13 will be located at least 2 mooring lengths (7 km) away from each other, becoming deployed to the West and to the East of 23°W, respectively. This seems overly cautious, as the moorings are designed to have minimal deflection in the vertical and horizontal, using ellipse shaped main buoyancy elements and a thin (6.5 mm diameter) mooring cable. For typical speeds of 0.25 m s^{-1} the expected maximum deflection will be 30-40 m in the vertical and 350-450 m in the horizontal (or ~0.01%f when in latitudinal direction, well within the frequency resolution of 0.002 cpd or 0.2%f after 500 days of deployment). This minimal distance is also some safety precaution for mooring recovery.

The moorings will mainly contain 5-6 current meters that are more or less evenly distributed along the mooring line, so that currents and temperature can be monitored across a large range in the vertical. The distribution of the current meters is adapted after inspection of deep CTD-data obtained during 'IRON(ages) from above' (Klaas Timmermans) in October 2002. These profiles show a strong pycnocline near 100 m, a nearly constant intermediate stratification between 100-1200 m, step like density profile between 800-1800 m and very weak stratification below 2000 m, with negligible stratification (N = 0) between 4000 and 4700 m. Current meters are planned in the step-profile layer and in the N = 0 layer, besides the even distribution over the mooring line. In the top of two moorings we also deploy a 75 kHz acoustic Doppler current profiler (ADCP), so that 10 m vertical shear (relevant for mixing induced by shear instability) is resolved over a range of about 500 m. In the bottom of one mooring highly accurate NIOZ thermistor strings will be moored, when possible. A fifth (additional) mooring, a bottom lander containing a 300 kHz ADCP, will monitor the bottom 80 m of the water column.

The instruments are adapted for long-term monitoring (extra batteries and, for some, extra memory). They are programmed to last 2 years whilst sampling relatively fast, at least once/15 min to resolve most of high-frequency internal wave motions in the deep ocean (where the buoyancy period is typically 20-30 min above 2000 m).

Additional measurements

Some additional CTD and lowered-ADCP (LADCP) measurements will provide indirect estimates of deep-ocean mixing all the way to the bottom, albeit to a limited temporal extent. Investigators from Tokyo Uiversity contribute to launch XCP (expendable current profilers) and XCTD, which provide independent estimates of turbulent mixing in the upper 1000-1500 m of the water column. Special focus is on differences in mixing across 30°N, due to expected changes in near-inertial current differences. They will also deploy XCP, XCTD whilst on transit from Texel-Madeira.

References:

Garrett, C., 2001. What is the "Near-Inertial" band and why is it different from the rest of the internal wave spectrum? J. Phys. Oceanogr., 31, 962-971.

Maas, L.R.M., 2001. Wave focusing and ensuing mean flow due to symmetry breaking in rotating fluids, *J. Fluid Mech., 437,* 13-28.

Siedler, G., and U. Paul, 1991. Barotropic and baroclinic tidal currents in the eastern basins of the North Atlantic. J. Geophys. Res., 96, 22,259-22,271.

van Haren, H., L. Maas and H. van Aken, 2002. Construction of internal wave spectrum near a continental slope. Geophys. Res. Lett., 29(12), 10.1029/2001GL014341.

abc. Passive sampling of organic contaminants in deep water layers (K. Booij)

Knowledge of organic contaminant transport in the environment primarily stems from measurements in terrestrial and coastal systems, particularly in the vicinity of densely populated areas. Data from remote areas are much less abundant. The evidence available for open ocean systems shows that distinct north-south gradients exist in atmosphere, water, and organisms. The general picture is that the more volatile compounds show an increase in concentration between the equator and the poles, and that the less volatile compounds show a decrease in concentration. The reason for this difference is believed to be related to the fact that the less volatile compounds need more time to establish a steady-state distribution. The existing models on global transport of organic contaminants identify the poles as the final sink where most of these compounds will condensate. Very little is known, however, to what extent the oceanic circulation plays a role in redistributing organic contaminants. The scarce information that is available for concentrations in the open ocean is limited to surface waters and the lower atmosphere. It is assumed that the ocean is vertically well-mixed with respect to organics, but no data is available to check whether this assumption makes sense at all. The situation is further complicated by the fact that the aqueous concentration (which is the quantity of interest, because it is closely related to the thermodynamic potential) of most organic contaminants is in the low pg/L range, necessitating large water volumes and low blank values. With the recent developments in the field of passive sampling of organic contaminants new methods have become available to address these issues. The samplers are typically small (which allows for low blank values) and the effective water volume that can be extracted with these devices can be quite high (m^3 range, depending on the compound). The effecting sampling rates are often the limiting factor, however (~ 10 L/d). The long-term mooring deployments within LOCO (> 1 year) create new opportunities to deploy passive samplers for prolonged time periods in remote areas in the deep oceans.

4. Participants.

Institute	*Name*
FYS	Hans van Haren (PI)
FYS	Kees Veth
FYS	Theo Hillebrand
FYS/DMG	Margriet Hiehle
FYS	Phil Hosegood
DEL	Martin Laan
DZT	Marcel Bakker
DZT	Yvo Witte
Univ. Tokyo	Maki Nagasawa
Univ. Tokyo	Michio Watanabe
Univ. Tokyo	Naoki Furuichi

NIOZ departments

FYS physical oceanography
MCG marine chemistry and geology
DEL electronics
DZT sea technology
DMG data management group

5. Data acquisition and instrumentation.

a. LOCO-IW moorings (Appendix A for the diagrams)

All four large moorings **(LOCO11-14)** have a single BMTI ellipse-shaped buoyancy element at the top, which also holds an ARGOS beacon. The moorings extend about ~3700 m above the bottom (~1500 m below the surface). They contain 5 current meters with temperature sensors. The current meters are positioned at 1600 (Valeport mechanical current meter), 2400, 3150, 3900 and 4500 m. The latter four current meters are acoustic Aanderaa RCM-11 (12) or Nortek AquaDopp (4). Additionally, one mooring contains an extra AquaDopp and an extra RCM-11 near the Valeport current meter for comparison. The RCM-11 sample at once per 900 s (15 min), the Valeport and the AquaDopp at once per 450 s (7.5 min), the latter with burst sampling at 1 Hz twice per day.

LOCO11 and **LOCO12** are two moorings that contain an upward looking 75 kHz ADCP in the ellipsoidal top buoyancy element. The range of the ADCP will cover 400-500 m of the water column, between 1000-1500 m, and sampling once per 900 s (15 min) every 10 m vertically.

LOCO14 is similar to the standard LOCO-13 and with one NIOZ-built thermistor string at 4500 m. This thermistor string samples once per 300 s (5 min). It is taped to the main mooring cable during deployment

b.Organic contaminants sampling (K. Booij)

Low-density polyethylene (LDPE) strips and triolein-filled semipermeable membrane devices (SPMDs) will be mounted in exposure cages that can be clamped to the mooring cable for moorings LOCO12 and LOCO13, at three water depths (Table below). The samplers absorb organic contaminants from the water phase. The uptake kinetics will be calibrated by measuring the dissipation of performance reference compounds (PRCs) that are spiked into the samplers prior to exposure. After exposure, the samplers will be extracted, and analysed for hexachlorocyclohexanes, hexachlorobenzene, polychlorinated biphenyls, polyaromatic hydrocarbons, and polybrominated biphenyl ethers.

mooring	Position on the cable	water depth (m)	sampler cage #
LOCO12	Below buoyancy element BMT	ca. 1460	1
,,	Below AQUADOPP	ca. 3115	2
,,	10 m above acoustic release	ca. 5180	3
LOCO13	below buoyancy element BMT	ca. 1450	4
,,	below AANDERAA RCM11	ca. 3110	5
,,	10 m above acoustic release	ca. 5180	6

c. DOC moorings (Appendix A for diagrams)

Moorings monitoring 'Deep Ocean Currents (DOC)' **DOC03-1 and DOC03-2** consist of the NIOZ-bottom lander 'mixBB' containing the large memory 300 kHz RDI-ADCP and, only for DOC03-1, one fast thermistor string (NIOZ-2). For reference and intercomparison, two acoustic current meters (Aanderaa RCM-11 and Nortek AquaDopp) were moored just above the thermistor string.

Fig calib Fig T string data?

DOC03-1 was moored at 526 m near the top of the eastern slope of Great Meteor Seamount (~30°N, 28°W). This is a pilot study to acquire some data in an area where LOCO-IW will be moved during future deployments. It is foremost a test for the NIOZ-2 thermistor string. The purpose of the equipment is to sample during one week at a fairly high temporal (0.1-1 Hz) and spatial (0.5-1 m) resolution the water temperature as well as all three components of velocity and the echo amplitude (backscatter strength). The latter constitute estimates on the relative variability of suspended matter in the water column. The purpose of the instrumental set-up is to estimate directly internal wave band eddy fluxes, besides the overall flow and temperature field within a range of about 80 m above the bottom. To this purpose memory capacity of the instrumentation is fairly large (450 MB for the ADCP and 512 MB for one thermistor string, 'NIOZ-2'). In order to associate the temperature variations to density variations a proper estimate of the temperature-density relationship is required by some local CTD sampling.

DOC03-2 is an additional mooring between LOCO-11 and LOCO-12 to monitor near-bottom inertial wave focusing (Maas, 2001) and long-term abyssal plain near-bottom currents in general. It will only hold a 300 kHz ADCP (and an ARGOS beacon). The ADCP will be sampling 80 1 m bins every 180 s (3 min).

d. Shipborne sampling

The Pelagia CTD/Rosette system contains a Seabird 911 CTD, with a Seapoint STM OBS. The CTD samples at a 24 Hz rate. The Rosette holds 22 12 l water bottles (standard). In-situ water sampling will be taken for filling sediment trap cups. The frame also holds a down- and an upward looking 1.2 MHz RDI ADCP, together forming the lowered ADCP (LADCP).

A second Rosette frame will be prepared without bottles. On this frame both NIOZ fast-thermistor strings will be mounted. With the core of the Pelagia CTD inserted, this frame will be lowered to 2800 m for in-situ calibration of the thermistor strings.

Sippican XCP (Expendable current profiler) and XCTD probes (University of Tokyo, Japan) will be used.

6. Daily summaries of LOCO-IW03.

Monday-Tuesday 24/25 February

Loading in NIOZ harbour. Departure for the Funchal, Madeira at 18.15 MET. Good weather conditions.

Sunday 02 March

13.54 UTC deployment of BOBO lander in the Nazaré Canyon, off Portugal.

Wednesday 05 March

09 UTC arrival in Funchal, Madeira.

Thursday 06 March

SE3. 7.30 UTC participants on board. 08 UTC departure for Canary Basin.

Friday 07 March

ENE4-5. 12 UTC. Turn around in direction of Funchal, Madeira because of death of father of one of the participants.

Saturday 08 March

E4-5. 18 UTC. Pilot station Funchal, Madeira.

Sunday 09 March

SE2. 16 UTC. First CTD: calibration NIOZ-2 thermistor string. Two concentrators, newly cast, start taking water: these are removed after calibration. One segment shows no data under water: probably badly soldered resistor. The concentrator print is replaced. CTD works fine.

Monday 10 March

S4-5. 6m swell. 16.30, 20, 23.30 UTC: XCP/XCTD stations along 28W.

Tuesday 11 March

NE5-6, 4 m swell. 10.30 UTC despite large swell successful deployment of the bottom lander with thermistor string mooring near the top of Great Meteor Seamount. After CTD/LADCP near the mooring, continue XCP/XCTD stations along 28W, to 28N.

Wednesday 12 March

NNE5.2-3 m swell. 10 UTC. CTD-calibration NIOZ-1 thermistor string.

Thursday 13 March

NE3-4.1-2 m swell. 15 UTC. Successful deployment of long mooring LOCO-11. 16 UTC CTD near the mooring, followed by triangular mooring location. Mooring LOCO-11 is within 30 m from the intended latitude!

Friday 14 March

E2-3.1-2 m swell. 10 UTC. Deployment of long mooring LOCO-12. 11 UTC CTD near the mooring. 17 UTC. Deployment of long mooring LOCO-13.

Saturday 15 March

ENE4.1-2 m swell. 05 UTC CTD near intended position of mooring LOCO-14. 10 UTC. Deployment of long mooring LOCO-14.

Sunday 16 March

E1-3.1-2 m swell. 03, 06.30, 10.30 UTC: XCP/XCTD stations along track towards mooring DOC01. 15 UTC successful recovery of bottomlander mooring DOC01, although the sounding was very bad. 17 UTC CTD above the steep bottom slope of the seamount. 19 UTC CTD for calibration of NIOZ-2 thermistor string.

Monday 17 March

NNE41-2.1-2 m swell. 22 UTC Deployment of bottomlander mooring DOC02. During descent CTD for calibration NIOZ-2 thermistor string. There was no problem in contacting the releases during the descent. However, contact was very difficult once the lander was at the bottom. Until 01 UTC attempted to contact to perform triangular location, which was not possible. Probably the releases are shaded by side-reflections off the glass spheres once the lander is at the bottom.

Tuesday 18 March

NE2.1-2 m swell. Transit to Madeira.

Wednesday 19 March

S4-5, 6 m swell. 1 UTC arrival Funchal harbour pilot station.11 UTC participants arrive in Funchal, Madeira, R.V. Pelagia leaves for Brest.

6. Scientific summary

a. Mooring deployments

The mooring deployment from the stern (except for ROCS02-1 from the side) worked flawlessly, due to good preparation and good weather conditions.

Acoustic ranging: different results? The positions of the moorings are in Table 1, and schematically in Fig. 3. The sediment trap/current meter moorings occupy the corners of a triangle, to be able to get some information on internal wave direction. The ADCP/thermistor string mooring is in the centre of the triangle.

Table 1. Mooring positions

ROC02-12975 m	54°10.050'N	-014 °01.132'W
ROC02-22981 m	54°11.710'N	-013 °52.760'W
ROC02-32969 m	54°12.884'N	-014 °08.327'W
ROC02-42579 m	54°05.301'N	-014 °03.707'W

Fig. 3. Schematic of relative positions of moorings at the foot of the continental slope in the Rockall Channel.

All moorings have been recovered successfully after six weeks of deployment, and the results are good as 80% of the instruments delivered good data (see below). No instruments were lost or irrepairably damaged. The new ellipse shaped floats worked very well (little mooring tilt). Slight disadvantage is that they laid 'low' on the surface. For future deployment it was recommended to put a flag on them and a ring or longer rope around them for easier catchment.

1. Current and temperature measurements mooring DOC01

All four ADCP's provided good data, 13 out of 16 current meters as well. Both thermistor strings show good data, although one logger leaked and the power supply of the other ended 8 hours before recovery. Detailed inspection of the raw data has to be done still, but the first analyses show some familiar, some new aspects.

The water column was very clear in terms of acoustic scatterers. As a result, the signal-to-noise ratio of the ADCP's was low and comparable with Antarctic waters, albeit varying strongly with time (Fig. 4) and space. On a diurnal time scale the range of good data varied between 300-500 m. Spatially, distinct layers with and without acoustic data are detected. As found during the pilot study, the strongest scattering layer coincides with the major pycnocline, which coincides with the layer of strongest shear. This layer varies in depth between about 350-500 m showing some diurnal variability with time, surprisingly. On the shorter vertical scales, closer to the bottom, the extreme frontal zones are again recognized, with currents accelerating from 0-40 cm/s within a minute (Fig. 5a), accompanied by strong bursts of acoustic reflection upon suspended particles (Fig. 5b) and strong temperature drops (see below). After such frontal passage, a group of velocity and acoustic reflection waves having typical periods of 10-15 min emerge, resembling internal solitary waves.

Fig. 4. Mooring PRO1b4 (600 m; Longranger BB-ADCP) vertical current shear for the entire period of measurements.The black band varying daily with time and 150 m vertically reflect 'bad' current measurements due to lack of scatterers.

Fig. 5. a.One hour of near-bottom current data at mooring PRO1a2 (494 m; 600 kHz BB-ADCP). Like in Fig. 4, the black band above 465 m indicates bad data due to lack of scatterers. b. The corresponding back-scattered echo intensity.

2. Deployment BOBO lander (by H. de Stigter)

On the March 2, 2003, at 13.54 UTC, a BOttom BOundary (BOBO) lander was deployed in the Nazaré Canyon off Portugal (Station 64PE208-01, 39°31.525'N 009°49.002'W, 3010 m). The BOBO lander, a free-falling tripod device of 4 m high, is equipped with an RD Instruments 1200 kHz ADCP, downward facing at 2 m above the bottom (a.b.), Seabird SBE-16 CT sensor at 3 m a.b., OBS sensors at 1 and 3 m a.b., an autonomous underwater filtration device with water intake at 1 m a.b., and a PPS sediment trap at 4 m a.b.. It is designed to record near-bottom hydrodynamical conditions and particulate matter fluxes, along with water temperature and salinity. Before the actual deployment of the lander, a limited echosounder survey of the projected landing site was made. Subsequent to deployment, acoustic ranging from three positions surrounding the deployment site was done to determine the accurate position and depth of the lander on the bottom. However, a difference of 50 m between the expected and calculated depth suggests that one or more of the rangings was incorrect. Recovery of the lander is planned for October 2003. The lander was deployed within the framework of the Canyons subprogram of the EU-funded research program Eurostrataform, which aims at determining sediment pathways and fluxes from the shelf to the deep sea.

b. CTD and water sampling

N profile! The CTD operations were 'normal', requiring cleaning in the start but no reparations. The most distinct different water mass was found at the depth of the main pycnocline (600-900 m depth). In detail down- and upcast occasionally showed differences in steppiness of the profiles (with typical step sizes of about 10 m only), evidnc of high-frequency wave activity or short-scale layering.

c. LADCP (by C. Veth)

This cruise was the first when 'workable' data have obtained with the FLYII microstructure profiler, acquired some 15 months before. The launching of this instrument with the line-puller system worked fine from the stern, upto wind force Bf7. The instrument measures turbulence

d. XCP (by M. Nagasawa)

This cruise was the first when 'workable' data have obtained with the FLYII microstructure profiler, acquired some 15 months before. The launching of this instrument with the line-puller system worked fine from the stern, upto wind force Bf7. The instrument

Fig. 9. a.Density stratification (buoyancy frequency squared) from CTD transect I. b. 'Raw' turbulent dissipation data from the same transect.

7. Concluding remarks

Despite the adverse weather during the first week and, associated perhaps, some misheaps like the mooring loss occurring in the same period, this cruise has been very successful. The successrate of the moorings, the completion of two cross-channel hydrographic and micro-structure surveys, the sediment sampling and the unexpectedly successful benthic sampling have resulted in an unprecedented detailed sampling of a continental slope. First analyses show that we captured fast and vigorous eventlike bursting of near-bottom processes. It remains to be investigated what process determines such events, whether by internal waves or not, and whether they are characteristic for the Faroe-Shetland Channel or for continetal slopes in general. The overall influence of internal wave activity in the basin awaits further analysis and comparison with numerical modelling.

This success could only be achieved by the harmonious collaboration of the entire group of people onboard, who managed to handle the good number of completely different activities in a harmonious way. On behalf of the participants, I would like to thank captain John Ellen and his crew of R.V. Pelagia for the very pleasant cooperation. Funding by the Netherlands Organization for the advancement of Scientific Research is gratefully acknowledged.

This was a very good cruise,
thank you all who made it such a success.

Appendix A Mooring diagrams (by. Dept. of Sea Tech.)

Appendix B Cruise summary of stations (activities) of LOCO-IW03

Station	Cast	DATE	Lat	Lon	Depth	Type
1	1	02/03/2003 13:54	39.5253	-9.8167	3010	deployment,BOBO
2	1	09/03/2003 16:04	31.7650	-21.4125	4957	CTD +Thermistor
3	1	10/03/2003 16:17	30.8870	-26.0001	5426	XCP
3	2	10/03/2003 16:27	30.8885	-26.0052	5414	XCTD
4	1	10/03/2003 20:02	30.7570	-26.6663	4926	XCP
4	2	10/03/2003 20:13	30.7527	-26.6737	4914	XCTD
5	1	10/03/2003 23:58	30.6285	-27.3342	4689	XCP
6	1	11/03/2003 00:06	30.6258	-27.3421	4695	XCTD
7	1	11/03/2003 03:38	30.4997	-27.9993	4487	XCP
8	1	11/03/2003 03:50	30.4900	-28.0031	4481	XCTD
9	1	11/03/2003 06:38	29.9995	-28.0000	4030	XCP
10	1	11/03/2003 06:49	30.0043	-27.9976	4006	XCTD
11	1	11/03/2003 10:07	29.9997	-28.3116	551	deployment, DOC01
11	2	11/03/2003 10:52	30.0094	-28.3175	563	CTD - samples
12	1	11/03/2003 14:52	29.5005	-28.0004	4432	XCP
13	1	11/03/2003 15:07	29.4828	-28.0003	4487	XCTD
14	1	11/03/2003 17:56	28.9986	-28.0008	4957	XCP
15	1	11/03/2003 18:07	28.9885	-27.9996	4957	XCTD
16	1	11/03/2003 20:55	28.4980	-28.0021	5048	XCP
17	1	11/03/2003 21:05	28.4878	-28.0034	5054	XCTD
18	1	11/03/2003 23:51	27.9993	-28.0007	4762	XCP
19	1	12/03/2003 00:02	27.9862	-28.0023	4969	XCTD
19	2	12/03/2003 00:46	27.9987	-28.0008	4768	CTD - samples
20	1	12/03/2003 10:06	28.3795	-27.0503	5067	CTD - samples
21	1	13/03/2003 13:17	30.1809	-23.0753	5164	deployment, LOCO 11
22	1	13/03/2003 15:52	30.1817	-22.9714	5158	CTD - samples
23	1	14/03/2003 08:35	30.0001	-23.0755	5134	deployment, LOCO 12
24	1	14/03/2003 10:43	30.0004	-22.9807	5115	CTD - samples
24	2	14/03/2003 15:49	29.9830	-23.0221	5121	deployment, LOCO 13
25	1	15/03/2003 05:03	28.7998	-23.0000	4975	CTD - samples
26	1	15/03/2003 08:37	28.7995	-23.0504	4981	deployment, LOCO 14
27	1	16/03/2003 02:46	29.4902	-26.0002	5237	XCP
28	1	16/03/2003 02:57	29.4909	-26.0109	5079	XCTD
29	1	16/03/2003 06:19	29.6369	-26.6667	5140	XCP
30	1	16/03/2003 06:33	29.6412	-26.6875	5134	XCTD
31	1	16/03/2003 09:51	29.7831	-27.3338	4945	XCP
32	1	16/03/2003 10:00	29.7851	-27.3409	4951	XCP
33	1	16/03/2003 10:12	29.7890	-27.3594	4951	XCTD
34	1	16/03/2003 10:47	29.8145		4890	XCTD
35	1	16/03/2003 15:10	29.9961	-28.3094	536	recovery, DOC01
36	1	16/03/2003 17:10	29.9999	-28.1811	2530	CTD - samples
36	2	16/03/2003 19:01	29.9999	-28.1810	2518	CTD +Thermistor
37	1	17/03/2003 21:41	30.0903	-22.9668	5073	deployment, DOC02
37	2	17/03/2003 21:47	30.0900	-22.9665	5073	CTD +Thermistor

Xtra scientif.

Susbsection on calibration procedure t-string

+ MOORING DESIGN/DEPLOYMENT(DZT/Hill)