Reference:
van Haren, H., 2009. Cruise report bsik/LOCO-IW09: R/V Pelagia cruise 64PE308, 21 June – 13 July 2009, NIOZ, 48 pp.

Cruise Report

bsik/LOCO-IW09

R/V Pelagia cruise 64PE308
21 June – 13 July 2009
Fortaleza (Ceará, B) – Las Palmas (Canarias, E)

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(with contributions from participants)

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(Photo: E. Keijzer)

0. Contents

1. Summary of R/V Pelagia LOCO-IW09 cruise

In June/July 2009 the R/V Pelagia (NIOZ, the Netherlands) sailed to the Brazil (Ceará) and Canary Basins (North-Atlantic Ocean), mainly to recover large moorings within Long-term Ocean-Climate Observations ('LOCO') and BSIK. LOCO is a large investment program funded by N.W.O., the Netherlands Organization for the advancement of scientific research. It aims to investigate ocean physics process variations on time scales of years using long-term moorings. In the deep North-Atlantic basins we study detailed variations in waves in the ocean interior ('internal waves', IW), especially the most energetic 'near-inertial' waves, and their impact on deep-ocean mixing and the large-scale ocean circulation. In some details, tidal IWs are studied above underwater seamounts. A portion of BSIK-funding is reserved for earth climate systems and the influence of variations in the ocean therein.

The main working area of LOCO-IW is the abyssal plain in the Canary Basin near 30º N, 23º W (~5200 m depth), with extensions to the Cape Verde Basin and, during this cruise, to the Brazil Basin. In November/December 2007 eight long moorings were deployed for the duration of 1.5 years between 0 and 2.5ºN, around 38º W, and between 27º and 30º N, roughly along 24º W. The long moorings reached up to 4000 m above the bottom. They consisted of 5 current meters sampling generally once per 15 minutes. Five moorings also carried a 75 kHz acoustic Doppler current profiler (ADCP) in the top buoyancy element. During LOCO-IW09 all moorings were successfully recovered and with very limited instrumental failure, the net result was better than 90% good data. A special result was obtained from NIOZ-built accurate thermistor string #3 sampling at 1 Hz: 45 out of 50 sensors sampled more than one year of data providing very detailed internal wave information.

Two short-term moorings were put on and near a seamount in the Brazil Basin to study internal waves and other near-equatorial current variations in a region of dramatic Coriolis force change. During the cruise several conductivity-temperature-depth (CTD) profiles were obtained in conjunction with lowered-ADCP (LADCP) to map the finescale and background hydrography. CTD-LADCP and ship's winches worked flawlessly. For the first time, shipborne EK500 echo sounder data were logged successfully and stored. Finally, seismic airguns and receiver-array was towed over the open basin near the short-term moorings sea mount to monitor near-surface small-scale internal waves and wave-beams. This towing was partially done in conjunction with towed NIOZ4-thermistors. A new type of water sample bottles was extensively tested.

The cruise was very successful. Weather conditions were good causing no delays.

2. General research aim.

LOCO

The N.W.O.-financed large investment program 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 are 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 are deployed for periods of up to 7 years, so that also variations due to the El-Niño cycle and the North Atlantic Oscillation are 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 extends existing time series and/or monitoring programs.

LOCO-IW

Within LOCO two sets of four moorings are used to study in more detail the climatologic mean of spatial and temporal variability of internal-wave intensity. This is done for different types of basins (above sloping topography and far away from boundaries in deep-ocean basins). The first set of these moorings is 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, the Cape Verde Basin towards the Equator to study specific processes like near-inertial wave propagation. Together these sites are exemplary for most internal wave appearances.

LOCO-IW Ceará and Canary Basins

The purpose of the LOCO-IW09 cruise is twofold. Near 30° N, we study near-inertial internal motions generated by atmospheric disturbances and those by diurnal tides. Near the equator we study internal waves in an area where the inertial frequency is small. During the cruise 8 moorings are recovered. Most moorings extend 3.7 km above the bottom (~1.5 km below the sea surface). Thesy contain current meters and temperature sensors. The moorings were in position for 1.5 years. In addition, short-term hydrographic and mixing information is collected using CTD, LADCP, seismic oceanography and towed thermistors, together with fast-sampling moored instruments.

3. LOCO-IW09 overview.

Internal wave mixing is thought to be the key in maintaining the large-scale meridional overturning circulation in the ocean. This mixing is induced about half by tidal motions and half by inertial motions following geostrophic adjustment. It is thought but not established that most energetic inertial motions are induced following atmospheric (wind) disturbances. As sinusoidal 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 important because of their strong shear due to their short vertical scales. Tidal motions are important because of persistent generation and potential focusing in basins. 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 cruise of LOCO the aim is on studying the variability with time of deep-ocean near-inertial and internal tidal motions in two areas (Fig. 1a). One area is where deterministic (diurnal tidal) forcing of near-inertial motions may be important. Also, at these ‘diurnal critical latitudes’ between latitudes |φ| = 27 and 30° energy at the diurnal tidal/inertial frequency may be enhanced due to transfer of energy from semidiurnal tidal frequencies to smaller scales at half their frequency via parametric subharmonic instability (PSI), also called subharmonic resonance. The associated reduction in vertical scales may imply larger shear-induced mixing. Secondly, an important focus is on the equatorial region where important ocean dynamics change because the vertical component of the Earth’s rotation (Coriolis force) becomes very small. Within a range of φ = ±1.5° the dynamical influence of the horizontal component of the Earth rotational vector is no longer negligible. This and other equatorial dynamics is specifically studied using five long-term moorings (Fig. 1b).

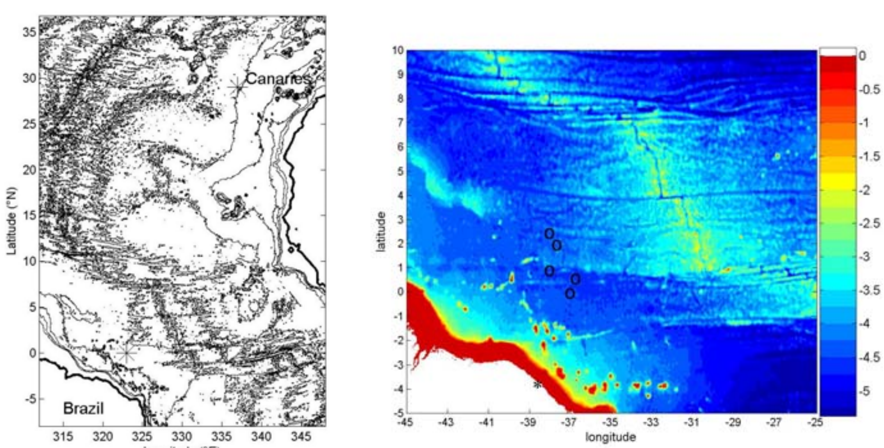

***Figure 1**. Left. Atlantic Ocean with main areas of investigation (*). Right. Ceará Basin to the north of Brazil, with Fortaleza (*) and 5 moorings (o) indicated.*

Most moorings are above the abyssal plain, but some of the attention is focused on near-equatorial underwater mounts using short-term moorings equipped with high-sampling rate instruments. There, vigorous non-linear breaking waves can occur (van Haren, 2005a).

LOCO-IW moorings

An array of long (~3.7 km) moorings LOCO11-18 were deployed during previous cruise LOCO-IW07. Three moorings are in the Canary Basin halfway between the continental slope and seamounts of the Mid-Atlantic Ridge and five are close to the equator, north of Brazil (Fig. 1; Table 1). During the LOCO-IW09 cruise all are successfully recovered.

Table 1. Moorings deployed during LOCO-IW07 with local inertial frequencies f in cycles per day (with harmonic diurnal tidal names between brackets). Depths are echo sounder estimates.

Mooring	*Latitude*	*Longitude*	*depth*	*f*
LOCO11/4	29°59.980'N	022°59.594'W	5115 m	1.0027 cpd (K_1)
LOCO12/4	28°48.037'N	024°05.915'W	5140 m	0.9662 cpd (M_1)
LOCO13/4	27°36.756'N	024°31.240'W	5152 m	0.9295 cpd (O_1)
LOCO14/4	00°00.013'N	036°59.466'W	4492 m	$7.6 \cdot 10^{-6}$ cpd
LOCO15/4	00°36.050'N	036°45.651'W	4504 m	0.0210 cpd
LOCO16/4	00°57.052'N	037°54.258'W	4475 m	0.0333 cpd
LOCO17/4	02°00.106'N	037°40.822'W	4420 m	0.0701 cpd
LOCO18/4	02°30.171'N	038°01.640'W	4450 m	0.0876 cpd

As part of the aim is to study inertial internal wave motions near the latitude where their frequency is close to diurnal tidal frequencies, some of the moorings are located sharply at and very close to those corresponding to tidal harmonic frequencies (Table 1). The horizontal distances between moorings and inertial/half-tidal latitudes are half an order of magnitude less than theoretical predictions on near-inertial wave propagation from the surface down- and equatorward in a flat ocean (about 300 km; Garrett, 2001) or following a prediction on down- and poleward propagation of near-inertial waves focusing on a spherical shell (about 100 km; Maas, 2001). The former theory seems an overestimate as it predicts a shift of ~5-9% in inertial frequency between surface and bottom, whilst analysis on historic data from IfM Kiel (Siedler and Paul, 1991) shows vertical frequency shifts much less than this (van Haren, 2005b). Within the equatorial band a sharp transition in rotational and internal wave motions is expected in the range between 1.5 and 2° (Dengler and Quadfasel, 2002; van Haren, 2006). There, particular latitudes are less critical than in the Canary Basin, but the same standard of positioning is used. After triangulation, each anchor position is known to within 10 m.

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 0.15 m s^{-1} the expected maximum deflection is estimated to be 3-4 m in the vertical and about 100 m in the horizontal (or <0.01%f when in latitudinal direction, well within the frequency resolution of 0.002 cpd (cycle per day) or 0.2%f after 500 days of deployment).

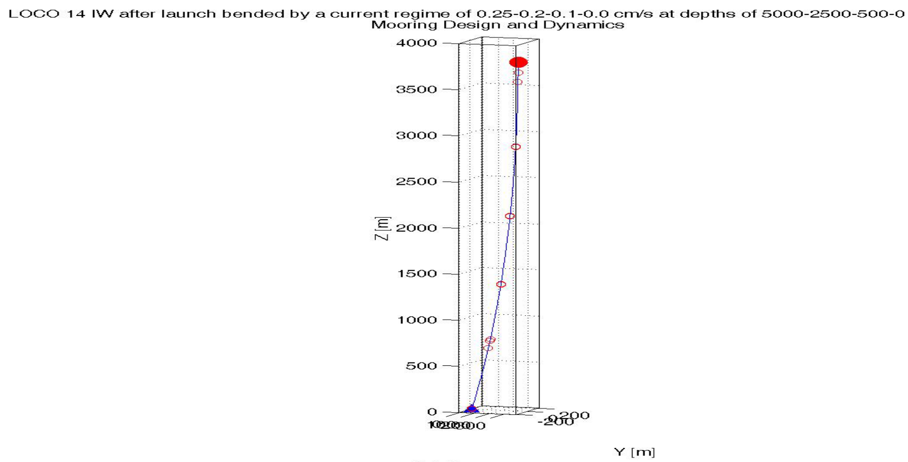

Figure 2. *Mooring deflection as computed by T. Hillebrand using program package designed by R. Dewey (UVic, Canada).*

The moorings basically contain about five 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 (Appendix A). For the Canary Basin, the distribution of the current meters is chosen after inspection of deep CTD-data obtained during previous cruises (Fig. 3). These profiles show a strong pycnocline near 100 m, a nearly constant intermediate stratification between 100-1000 m, steplike density profile (partially due to double diffusive mixing) between 800-2000 m and decreasing stratification below 2000 m, with sometimes negligible stratification (N = 0) between 4000 and 5000 m. Current meters are planned in the step-profile layer and in the N → 0 layer, besides the even distribution over the mooring line.

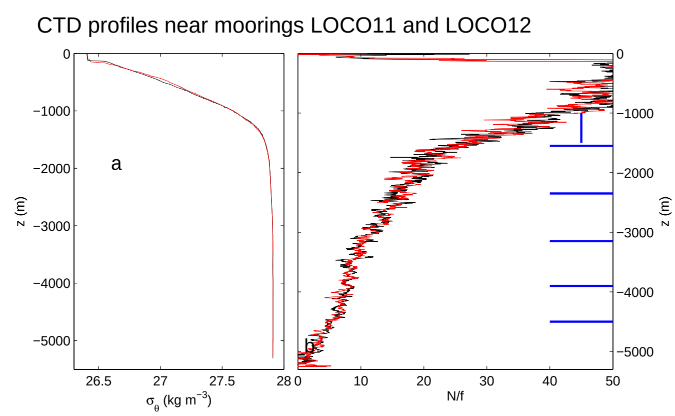

Figure 3. *a. Density anomaly and b. 40 m smoothed stratification with depth, scaled with f(30°). Horizontal lines indicate proposed current meter locations; vertical line shows the range of the ADCP.*

In the top of some, unfortunately not all, moorings a 75 kHz ADCP is deployed, so that ~20 m vertical shear (relevant for mixing induced by shear instability) is resolved over a range of about 500 m.

The instruments are adapted for long-term monitoring (extra batteries and, for some, extra memory). They are programmed to last 1.5 years whilst sampling relatively fast, at least once/30 min, generally once/15 min, to resolve most of high-frequency internal wave motions in the deep ocean. There, the buoyancy period is typically 60 min or more below 1500 m, while ~30 min at 1000 m. The bulk of the current meters are acoustic measurement devices, like the ADCP. All such devices rely on particles (plankton, suspended sediments) in the water for sufficient signal-to-noise s/n ratio. Presently, they are reasonably robust in their performance, but, unfortunately, their deep-ocean s/n allows some limited internal wave band resolution of only up to 5(10) cpd (cycles per day). In contrast, mechanical current meters can resolve frequencies up to about their Nyquist frequency (~20-40 cpd), but these instruments do rely on sufficiently strong currents (>0.02 m s^{-1}) and risk entanglements with floating material like lines etcetera. Such mechanical devices are only used at depths shallower than 2000 m, due to pressure housing problems.

Additional measurements

CTD and lowered-ADCP (LADCP) measurements provide indirect estimates of deep-ocean shear and mixing (eddy diffusivity) all the way to the bottom, albeit to a limited vertical resolution (~25 m) and, of course, limited temporal resolution. These measurements are made near most moorings and on two yoyo stations near a seamount in the near-equatorial region.

Near a small underwater mount in the near-equatorial region attempts are made to monitor small-scale internal wave motions and beams using ‘seismic oceanography’ equipment. Here, it is specifically also used to monitor changes in mixing and internal wave propagation in the narrow equatorial band. During these measurements fast-sampling instruments are moored near the top and the slope of the seamount on a bottom lander with a 2GB-300 kHz ADCP, NIOZ thermistorstring #3, NIOZ1 prototype of differential pressure sensor, 2 test current meters, and, on a separate mooring two 75 kHz ADCP’s and a string of 100 of the new NIOZ4 pressure insensitive thermistors.

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. 2004. LOCO-IW04-Canary Basin: R.V. Pelagia cruise 64PE231, 14 October-07 November 2004, NIOZ, 39 pp.

van Haren, H., 2005a. Details of stratification in a sloping bottom boundary layer of Great Meteor Seamount. Geophys. Res. Lett., 32, L07606, doi:10.1029/2004GL02298.

van Haren, H., 2005b. Tidal and near-inertial peak variations around the diurnal critical latitude. Geophys. Res. Lett., 32, L23611, doi:10.1029/2005GL024160.

van Haren, H. 2005. Sharp near-equatorial transitions in inertial motions and deep-ocean step-formation. Geophys. Res. Lett., 32, L01605, doi:10.1029/2004GL021630.

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.

van Haren, H., R. Groenewegen, M. Laan, B. Koster, 2005. High sampling rate thermistor string observations at the slope of Great Meteor Seamount. Ocean Science, 1, 17-28, SRef-ID: 1812-0792/os/2005-1-17.

4. Participants.

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NIOZ departments

FYS	physical oceanography
DMG	data management group
MTE	electronics
MTM	sea technology
MTI	fine mechanics instrumentation

5. Data acquisition and instrumentation.

a. LOCO-IW07 (/4) moorings (Appendix A for diagrams)

All eight large moorings **(LOCO11/4-18/4)** have two ellipse-shaped buoyancy elements near the top, of which the upper also holds an ARGOS-satellite beacon. The tension in the 0.0065 m thin steel mooring cable varies between 3500 and 5500 N. About 5 m above the steel weight (500-800 kg) two IXSea acoustic releases are mounted. Most current meters (CM) are acoustic Aanderaa RCM-11 and Nortek AquaDopp, with the upper mainly being a mechanical Valeport BFM308. We had problems with this current meter in the past (leakage, explosion). This time, after modification and re-guarantee to 2000 m only one leaked, but quite some impellors were blocked. As the moorings will be in position for 1.5 years, the RCM-11 sample at once per 900 s (15 min; if machines are not modified to have this option they run at once per 20 min), the Valeport at once per 5, 7.5 or 10 min and the AquaDopp at once per 15 min, with burst sampling at 1 Hz once per day.

Moorings **LOCO11/4, 12/4, 14/4, and 18/4** contain an upward looking 75 kHz ADCP in the top buoy whilst **16/4** a downward looking. The range of the ADCPs covers 500 m of the water column every 10 m vertically, between about 1000 and 1500 m (**11/4 and 12/4**) or 500 and 1000 m (**14/4 and 18/4**). They sampled once per 900 s (15 min). Mooring **LOCO16/4** holds 51 NIOZ-3 sensors on a 285 m long cable between the two ellipse buoys. Therefore, the ADCP is mounted downward looking, with a range between 1000 and 1500 m.

Elliptically shaped buoy with ADCP and ARGOS beacon.

b. DOC09 moorings (Appendix A for diagrams)

DOC09-1 is a lander-mooring with 55 NIOZ-3 1Hz-sampling rate thermistor sensors, which is moored at ~1650 m on the northern slope of a near-equatorial Seamount (~1.35°N, 38.64°W). The instrument, below a ~200 kg elliptic buoy and a novel RDI-DVS CM and a test-Aanderaa Seaguard CM is attached to NIOZ mix-BB002 bottom lander holding a 300 kHz RDI Sentinel, with 2 GB memory and 2 extra battery containers and a second RDI-DVS CM. The purpose of the equipment is to sample during 7 days at a fairly high temporal (0.1-1 Hz) and spatial (0.5 m) resolution the water temperature, pressure and currents above the top of a deep steep slope. In order to associate the temperature variations to density variations a proper estimate of the temperature-density relationship is required by some local CTD calibration sampling.

DOC09-2 is a mooring with two 75 kHz ADCP's, one upward looking, the other downward, to monitor the high-frequency shear variability over a large range (nearly surface-bottom). They ping asynchronously during 8 s each, before a 7 s rest, so that the data are ensemble averaged over 30 s. Above the upper ADCP 100 new, potentially pressure-free NIOZ4 thermistors are mounted. This mooring is located near DOC09-1, but twice as deep (3200 m; 1.38°N, 38.62°W).

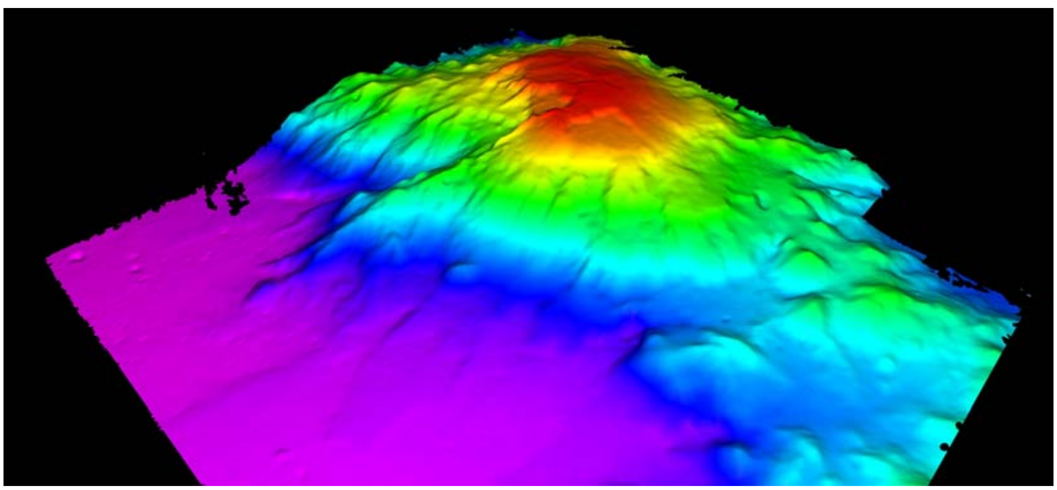
Photo (J.D. de Visser): NIOZ bottom lander mixBB-002.

c. Shipborne sampling

The Pelagia CTD/Rosette system contains a Seabird 911-*plus* Conductivity Temperature Depth sensor, with a Seapoint STM Optical BackScatterer (OBS). The CTD samples at a 24 Hz rate. The Rosette frame holds a downward looking 0.3 MHz RDI ADCP, called the Lowered ADCP (LADCP). Unfortunately its upward looking associate was not replaced in-time for this cruise. On the Rosette frame NIOZ3 and/or NIOZ4 high-sampling rate thermistors are mounted four times for their in-situ calibrations. As a test three NIOZ-built open tube water sampling bottles were mounted to the frame.

d. Seismic oceanography

A relatively new tool for oceanographic semi-synoptic observations is the use of seismic reflections in the water column. Such reflections on sudden temperature variations are weak, but in principle detectable when a multi-receiver array is used. If so, they provide a resolution of about 10x10 m. The NIOZ 5-airguns seismic array will be used, totaling ~100 $inch^3$, together with a 24-receivers streamer array. It is used in the near-equatorial region.



(M. Hiehle and H. de Haas): Multibeam map of unnamed near-equatorial seamount.

6. Daily summary of LOCO-IW09.

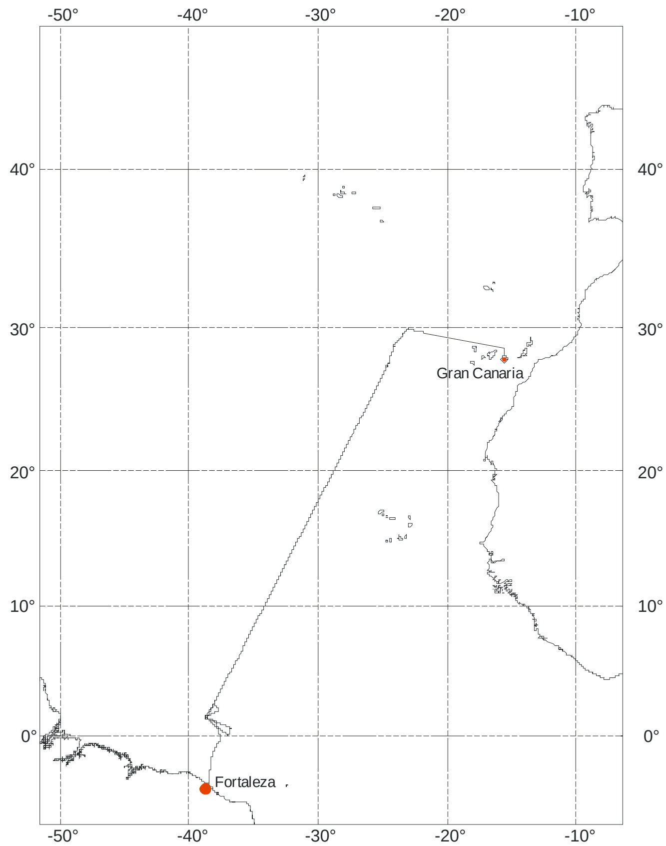


***Figure 4**. LOCO-IW09 cruise track (M. Hiehle).*

Sunday 21 June

24 UTC. Departure from Fortaleza, Brazil, one day behind schedule due to late arrival of the vessel. E3, warm. Change shiptime to UTC-2 h.

Monday 22 June

ESE3, showers. Transit to Céara Basin. 22 UTC first CTD/LADCP+calibration thermistors and bottle test. Regular squid sightings and fishing. A ray passes by.

Tuesday 23 June

ESE4. Springtide. 10 UTC. Successful recovery of mooring LOCO16/4. 20 UTC deployment of lander DOC09-1, 23 UTC deployment of mooring DOC09-2.

Wednesday 24 June

E2-3. 12 UTC Successful recovery of mooring LOCO15/4. In the afternoon followed by successful recovery of mooring LOCO14/4. So far all moored instruments have worked flawlessly, except that we cannot access 2 out of 3 Valeport current meters. Later, CTD/LADCP and first water sampling bottle test.

Thursday 25 June

SE2-3. 14 UTC. Start of 25 h yoyo-CTD station halfway between moorings DOC09-1 and DOC09-2.

Friday 26 June

SE3. 15:30 UTC. End of 25h yoyo-CTD. Afternoon is used for seismic and towed-thermistor string tests.

Saturday 27 June

SE3. 00:20 UTC. Start of 12h yoyo-CTD, just deeper than DOC09-2. 12 UTC end of yoyo-CTD. 14 UTC start of seismics.

Sunday 28 June

SE3, showers. 10 UTC. End of seismic. 13 UTC start with seismic and towed thermistor string combination. First tropical bird sighting.

Monday 29 June

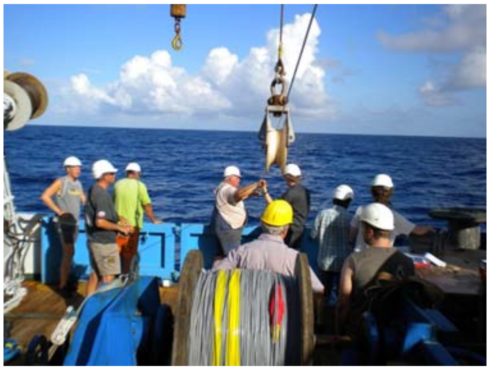
NE3-4, showers. 10 UTC. Successful recovery of mooring LOCO18/4. In the afternoon successful recovery of mooring LOCO17/4 followed by CTD/LADCP and new bottles closure. Valeport current meters are finally read successfully.

Tuesday 30 June

E3. 08 UTC. Successful recovery of mooring DOC09/2, followed by successful recovery of lander mooring DOC09/1. This is the end of the near-equatorial activities. Set course to the Canary Basin. It starts raining at the end of the day.

Wednesday 01 July

E3, showers. Sighting of a pot of 6 pilot whales.



Thursday 02 July

NE3-4.

Friday 03 July

NNE3-4.

Saturday 04 July

NNE4. 16 UTC. Bottle test CTD. Change shiptime to UTC-1h.

Sunday 05 July

NNE3.

Monday 06 July

NNE2-3, first cloudfree day. 16 UTC. Bottle test CTD to 500 m. Problems with closure, possibly due to temperature effects.

Tuesday 07 July

NE2-4.

Wednesday 08 July

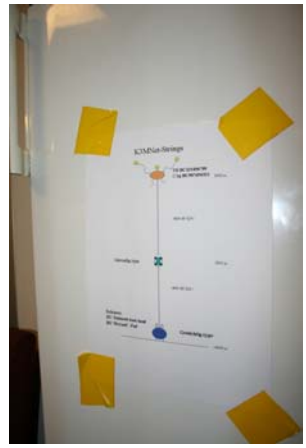
NNE2-3. Springtide. 15 UTC. Bottle test CTD to 2500 m. Successful closure.

Thursday 09 July

NE2. Successful recovery of mooring LOCO13/4, followed by CTD/LADCP. New bottles closure at 5100 m: perfect result.

Friday 10 July

ENE3. Successful recovery of mooring LOCO12/4, followed by CTD/LADCP. Air problem in new bottles.



Saturday 11 July

NE2-3. Successful recovery of mooring LOCO11/4, followed by CTD/LADCP. Air problem new water sampling bottles solved. 14 UTC, we set course to Las Palmas.

Sunday 12 July

NE3-4.

Monday 13 July

NE3. 15 UTC. Arrival Las Palmas.

7. Scientific summary and preliminary results.

a. Long-term mooring recoveries

All recoveries were done by approaching the buoy from the ship's starboard side, with a line from the stern-winch laid out on the starboard side to the side-winch. From the side-winch deck a small dredge was thrown to catch the line between a small float and the surface buoy. This 20 m line was sufficient and easy to catch. The detachment of the large elliptical buoys from the mooring line was fairly easy due to the chain below the upper buoy and on both sides of the inline buoy. This chain was about 1.5 m in length.

All eight moorings deployed during LOCO-IW07 were successfully recovered. The instrumental performance was good (see Table 2). No substantial bio-fouling was found. No corrosion was observed at IXSea (Oceano) acoustic releases, but the coupling between the releases was heavily corroded on some equatorial moorings. Like in 2007, of most moorings only one release responded immediately, the other only after several attempts or not at all.

The taught-wire mooring design is very successful: we learned from the tilt- and pressure sensors in ADCP's and AquaDopp's that the moorings never tilted more than 2.5°. As a result maximum deviations due to current drag were 3 m in the vertical and 150 m in the horizontal, which is extremely good and better than expected from our model estimates (Fig. 5 compare with Fig. 2). In addition, pressure decreased some 3 m gradually over time. This is attributed to stretching of the mooring, by about 1 mm/m, over a period O(100 days).

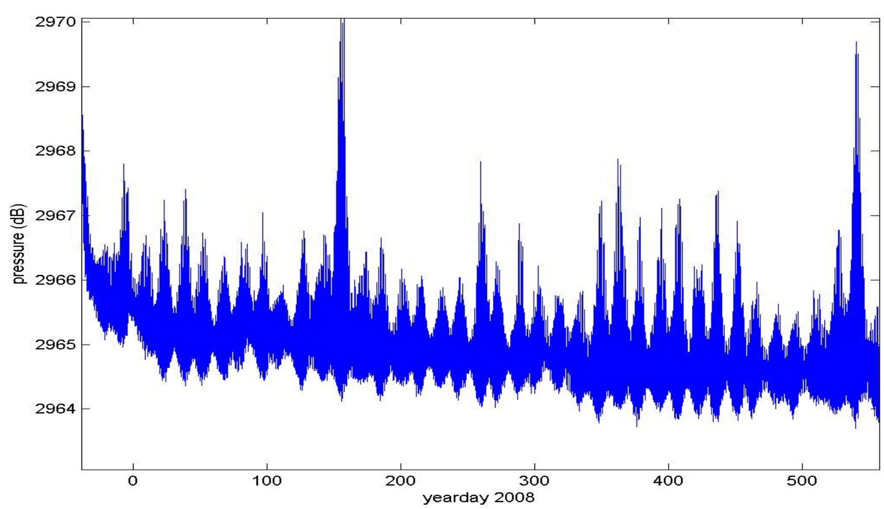


Figure 5*. Pressure measured by AquaDopp in mooring LOCO11/4. The stretching of the cable results in a decrease in pressure, which takes nearly the entire mooring period. The fortnightly spring-neap modulation is the actual surface tide measured. The asymmetry in this pattern, with peaks to higher pressure values, is due to mooring deflection, which amounts a few dBar (~m) only. Time in yeardays 2008, with days 2007 -365 and days 2009 +365.*

Of the 49 instruments deployed, 48 current devices and one thermistor string, 44.75 worked more or less flawlessly as intended and 2 completely failed. Of the remaining 2.25 failures, the half stands for about half of the thermistor string sensors, the other data showing gaps either in date or speed being 0. Thus we arrive at a result of 90% good data, a high percentage.

Of the different current meter devices, the mechanical Valeport BFM-300 gave better data, in principle, but the instrument is not entirely reliable. Again, one instrument leaked and 4, out of 7, showed impellor problems, often indicating 0s. All acoustic instruments were noisier than the mechanical current meter. Of these, Aanderaa RCM-11 was least noisy but one instrument completely failed and another two showed timing problems with DSU so that data records are not complete. Moderately noisy was the more attractive Nortek Aquadopp, of which none failed. This time, through different programming, no noise difference was encountered at the deepest instruments. On the other hand, the advantage of this instrument remains in: better clocks, vertical currents (upper instruments only gave significant signals) and indispensable tilt and pressure information besides a better temperature resolution. Unfortunately, its echo information is useless. The noisiest 75 kHz RDI-ADCP also never failed. Its important feature of 10-m shear only extended above noise level in the inertial band. On the other hand, its vertical current well-resolved motions near the buoyancy frequency. As before, its echo intensity data showed magnificent diurnal, monthly lunar and seasonal variations, which are attributed to plankton migration in the vertical (Fig. 6).

Table 2. Data return of IW07 moorings.
CM-abbreviations: A=Aanderaa; N=Nortek; R=RDI; V=Valeport.
Sensors, A:C,R,T; R: C,R,T,p,tilt.
(C=speed, R=direction, T=temperature, p=pressure).

Moorings deployed November/December 2007, recovered during LOCO-IW09

Mooring	Instrument	BCode	depth [m]	sampl. int. [s]	remarks
LOCO11/4	R 75 kHz ADCP	888	1380	900	
	VBFM308	5333	1480	450	*15% 0-speed*
	A RCM11	1793	2180	900	T arctic readLOW
	N AqDop	2271	2930	900	
	A RCM11	1823	3680	900	T arctic
	A RCM11	1816	4430	900	T arctic
	samplers at several depths (Appendix A)				
LOCO12/4	R 75 kHz ADCP	1854	1430	900	
	A RCM11	4138	1530	1200	
	A RCM11	1861	2330	1200	T arctic stop aft 9 mo
	A RCM11	4114	3080	1800	No T
	A RCM11	1960	3830	1200	*No data*
	A RCM11	2356	4430	1200	T arctic
	samplers at several depths (Appendix A)				

LOCO13/4	VBFM308	5234	1150	600	0 speed after 4 days
	VBFM308	5241	1650	600	*drowned*
	N AqDop	11471	2350	900	
	A RCM11	765	3100	900	20% gaps
	A RCM11	758	3850	900	T arctic
	N AqDop	2288	4450	900	
LOCO14/4	R 75 kHz ADCP	5302	1000	900	TML 10m
	VBFM308	5265	1200	300	many 0 speed
	VBFM308	5357	1202.5	300	*too many 0 speed*
	N AqDop	11488	1800	900	
	N AqDop	12850	2500	900	
	A RCM11	1915	3200	900	T arctic
	A RCM11	2363	3900	1200	T arctic (LOW read)
LOCO15/4	N.AqDop	2295	1200	900	
	N AqDop	2264	1800	900	
	N AqDop	2318	2500	900	
	A RCM11	789	3200	900	T arctic
	A RCM11	1946	3900	900	T arctic
LOCO16/4	R 75 kHz ADCP	1342	1075	900	TML10m; downl.
	51 s.NIOZ3	--	1090	1	50 1 yr
	VBFM308	5227	1375	300	many 0 speed
	N AqDop	2325	1950	900	400 datap. Skipped
	N AqDop	2301	2650	900	
	A RCM11	703	3350	900	T arctic
	A RCM11	772	4050	900	T arctic
LOCO17/4	VBFM308	5340	1450	300	
	N AqDop	13185	2050	900	
	N AqDop	13208	2750	900	
	A RCM11	734	3450	900	T arctic
	A RCM11	2028	3452.5	1200	T arctic
	A RCM11	710	4150	900	T arctic
LOCO18/4	R 75 kHz ADCP	1953	1000	900	TML 10m
	VBFM308	5319	1200	300	*too many 0 speed*
	N AqDop	13192	1800	900	
	A RCM11	4107	2500	1200	T arctic
	A RCM11	727	3200	900	T arctic
	A RCM11	30045	3900	900	T arctic

The perfect positioning of the moorings, so that anchor locations are known to within 10 m horizontally and less than 100 m from intended latitude, makes any changes in inertial frequency easily verifiable to within the spectral resolution. Also, even the 2 s per day variation in RCM-11 clocks falls well within the spectral resolution. Nevertheless it is nicer to have more precise clocks, like in other instruments. Clock variations are verified using the major semidiurnal tidal constituent M_2. Sample spectra show internal wave kinetic energy spectra with familiar large peaks at tidal, inertial and higher harmonic frequencies (Fig. 6). The diurnal peak stands out in acoustic echo and vertical current variance, implying dominant zooplankton vertical motions. These species not only perform a diurnal vertical migration, but also a lunar monthly migration as evidenced from the diurnal frequency peaks, notably lunar M_1 halfway between O_1 and K_1 (Fig. 6b). Curiously, high-frequency internal wave motions are visible in horizontal kinetic energy and echo variance: the light bulges between 20 and 30 cpd. Such motions are expected in the vertical current variance, because internal waves become vertically oriented at their high-frequency end, as indeed observed standing out from the noise.

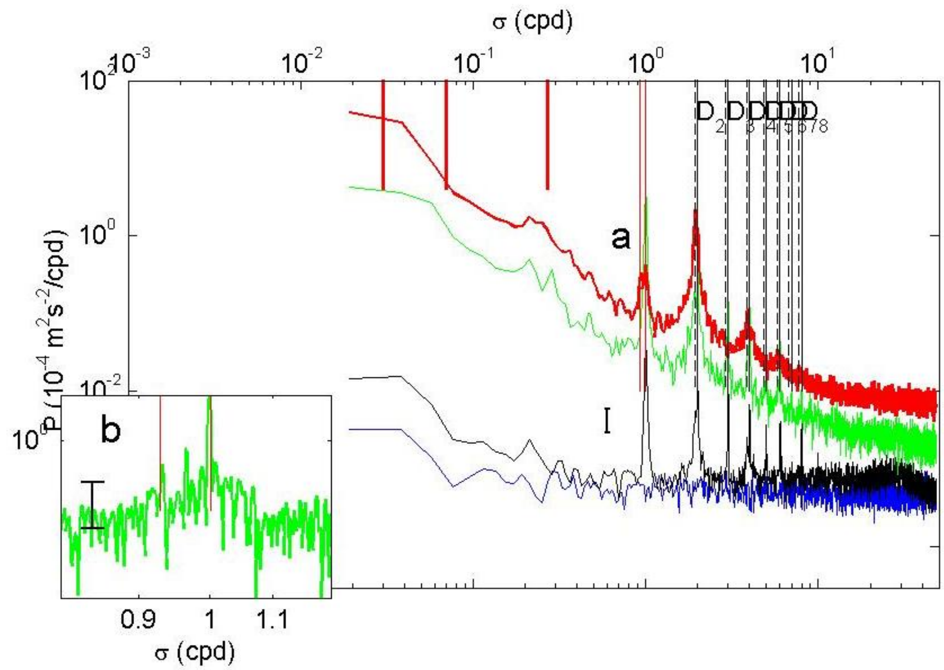


Figure 6. Spectra from near-equatorial ADCP data near 750 m, mooring LOCO14/4. a. Kinetic energy (red) in comparison with echo variance (green, arbitrary scale), and vertical current (black) compared with 'error velocity' noise variance (blue). b. Raw detail of echo variance in the diurnal band, vertical black lines indicate O_1 and K_1 (left, right).

b. NIOZ3 thermistor data

All of the 51 NIOZ3 sensors at LOCO16/4 were successfully recovered, and all of them recorded at least one year of data. 29 sensors worked properly during the entire duration of the mooring (530 days), continuously recording temperature at 1Hz, the 22 others encountered battery failure, most of them after 400 days of recording (Fig. 7). The calibration of the sensors remained remarkably stable; regarding the small range of temperature encountered during the recording (400mK ranging between 4.5 and 4.9°C), the 1mK accuracy of the sensors was totally adequate. Sensors were spaced every 6m over 240m, with additional sensors in the central region, covering a 6m band with 0.5m spacing. The long term temperature variations show stable intrusions of warmer water (necessarily compensated by salinity). Semidiurnal internal lunar tide M_2 has amplitude reaching 40 m, and is accompanied with a continuum of internal waves up to the buoyancy frequency around 30 cpd.

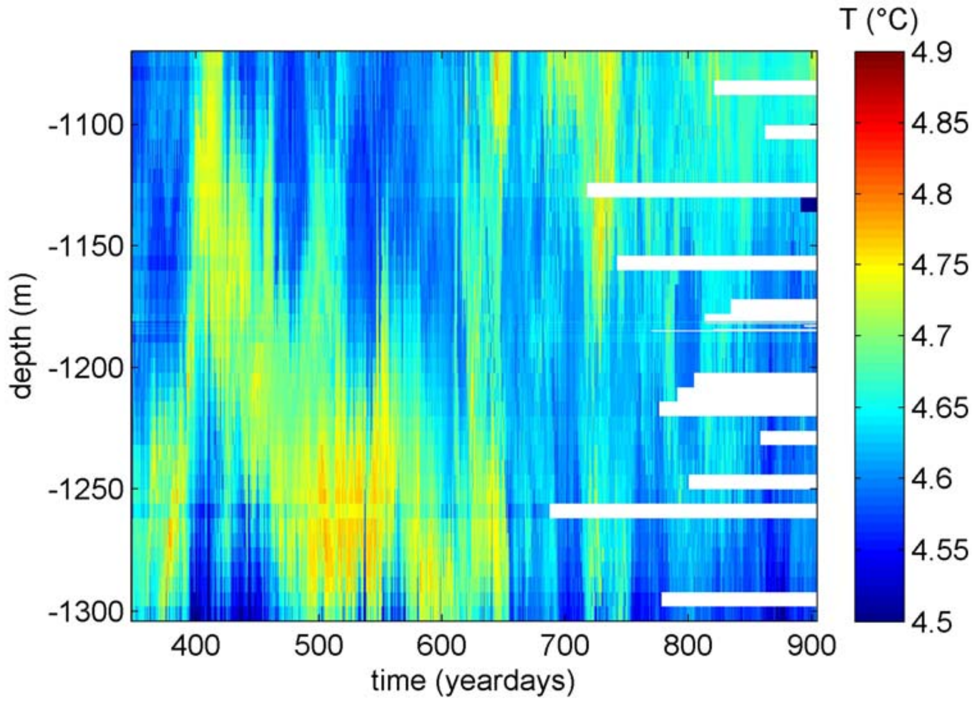


Figure 7. Overview of 1.5 years of NIOZ3 temperature data from mooring LOCO16/4. In white no data. Yeardays +365 in 2008 and +731 in 2009.

c. Short-term mooring deployment and retrieval

Bottom lander **DOC09-1** was moored for 6.5 days near the top of the northern slope of a little near-equatorial Searidge, at 1640 m (Table 3; Fig. 8). All instruments worked pretty well, except for one of the two new RDI-DVS current meters and the 300 kHz ADCP: due to lack of scatterers the data are extremely noisy. The test-Aanderaa Seaguard seems to have worked well, but the data are yet to be analyzed due to a reading problem. The NIOZ-3 thermistor string (57 sensors at 1.0 m intervals) returned 90% good data during the entire period (Fig. 9). The data are very alike those obtained in much shallower water near the top of non-equatorial Great Meteor Seamount, except for the temperature range. Like there, highly non-linear breaking waves are observed in the present data which vary approximately, but not exactly, with the dominant tidal periodicity. These waves are completely different from the interior, even when interior means close to but above the seamount (mooring DOC09-2).

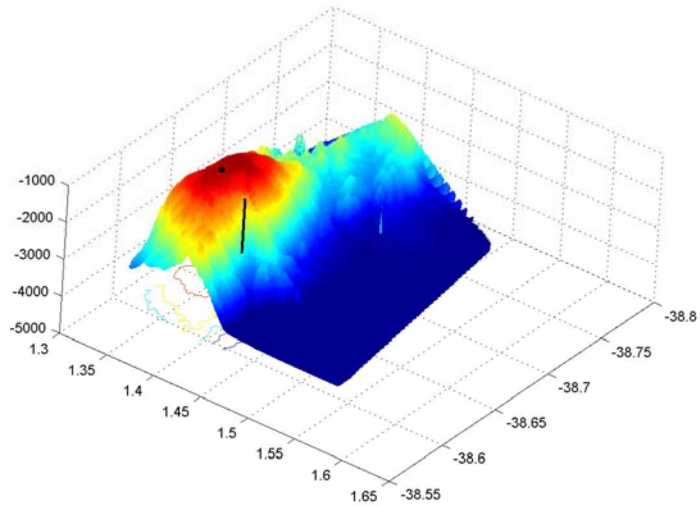


Figure 8. New seamount with position of DOC09-1 (black dot) and DOC09-2 (black line). Multibeam data, image by M. Hiehle and M. Mercier.

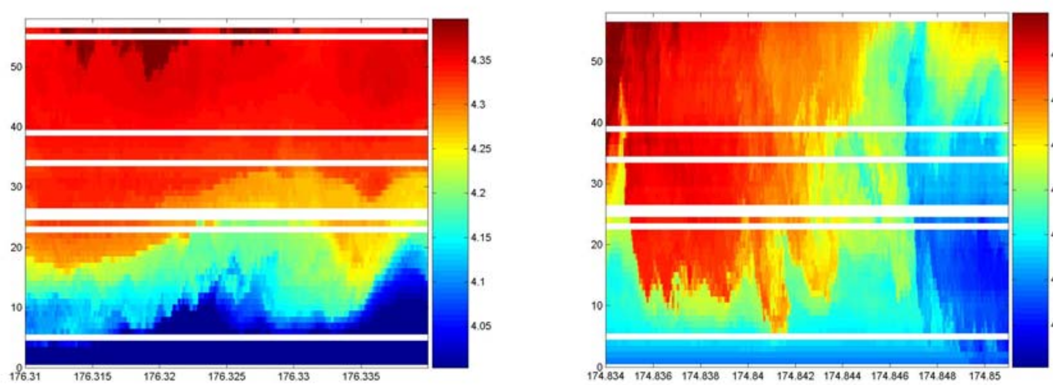


Figure 9. A few details of depth-time series showing near-bottom internal waves, NIOZ3 temperature in ℃ measured at DOC09-1: K-H billows hanging below a near-buoyancy frequency internal wave (left) and a frontal overturn with preceding overturns (right). Tie ins yeardays 2009, height above the bottom in m.

The two ADCPs on mooring **DOC09-2** have worked well, except that the downlooking instrument was noisier, but seemed alright otherwise. Noise variations with time in echo amplitude evidenced occasional rapid spin of the mooring line (up to one rotation per minute). Both instruments rotated in the same direction, despite swivels between them. Together, they gave a fantastic view across 1200 m of vertical currents, but especially also of relative echo amplitudes showing multiple layers of plankton motions and internal waves (Fig. 10).

Above the upper ADCP a string of 103 new NIOZ4-sensors were mounted. Three sensors failed and, unfortunately, some 35 were noisy (at these low temperatures). This has now been mended, but only after this first deployment. Otherwise, the sensors are well-functioning, with noise levels <0.1 mK. As before, the “interior”, above-seamount internal wave motions show large amplitudes, now typically 50 m, but are quite linear (Fig. 11).

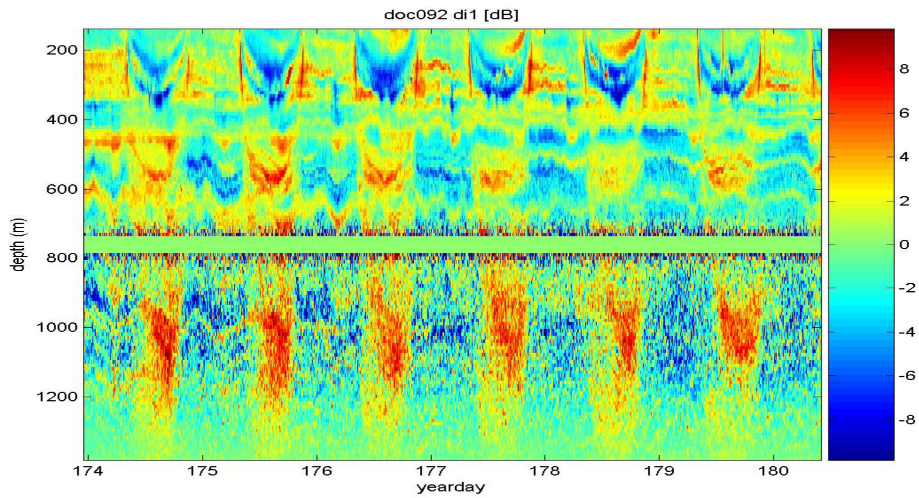


Figure 10. Relative echo amplitude in dB measured at DOC09-1 using two 75 kHz ADCPs at 770 m.Diurnal [plankton] variation is visible at multiple levels. The associated layering in amplitude variations is also moved up- and down by internal, notably semidiurnal tidal waves. Time is yeardays 2009.

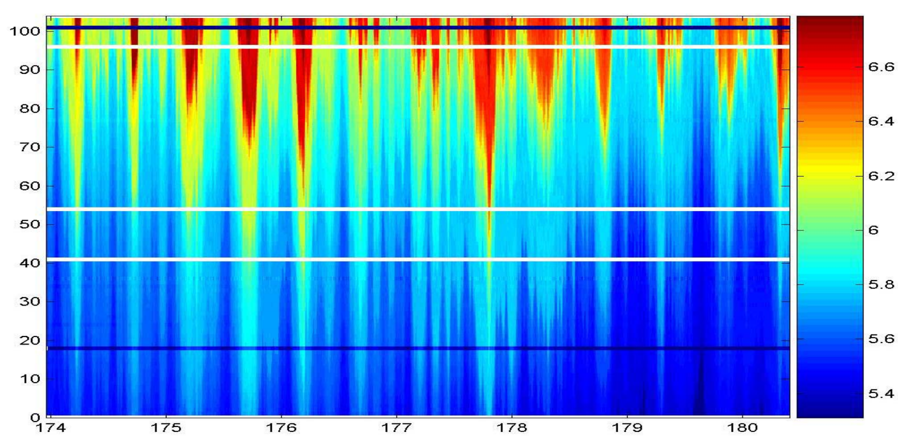


Figure 11. Overview of NIOZ4 temperature in ℃: internal waves measured at DOC09-2. Time in yeardays 2009 along horizontal axis, # of sensors at 1 m intervals along vertical axis: sensors are between 583 and 685 m.

Table 3. Moored instruments details of short-term deployment (A=Aanderaa; R=RDI).

LOCO-IW09 mooring between **23/06/09 - 30/06/09 at** 01°21.791'N 038°38.391'W 1640 m

Mooring	Instrument	depth [m]	sampl. int. [s]	remarks
DOC09-1	R DVS	1583	5	
	A Seaguard	1584	10	data Aanderaa
	FT-string#3	1638.6(lows.)	1	57 sens.; 10% sens. fail;.
	300 kHz ADCP	1634(fb)	2	TM3.0 m VERY noisy
	R DVS	1638.3	5	FAILED
	dprN1	1595	4	13.5 m length tube

LOCO-IW09 mooring between **23/06/09 - 30/06/09 at** 01°24.462'N 038°37.330'W 3263 m

Mooring	Instrument	depth [m]	sampl. int. [s]	remarks
DOC09-2	75 kHz ADCP	734(fb)	30	TM14 m Uplook
	75 kHz ADCP	786(fb)	30	TM14 m Downlook noisier
	FT-string#4	685(lows.)	0.5	103 sens.; 3 sens. fail; 1m dist..

d. CTD/LADCP sampling

The CTD/LADCP operations were 'normal'. The instrument, deck unit and the winch worked very fine. Unfortunately, like the preceding cruise LOCO-IW07 the LADCP consisted of only the downlooking ADCP, which complicates data processing. The LADCP-system has been applied during all CTD-casts across the entire water column. Twice a CTD-Yoyo station was performed, nearly 24 h and 12 h, in the vicinity of the DOC09/1 and DOC09/2 moorings.

*e. Test Ucc water sampling bottles (*by E. Keijzer & M. Laan*)*

The deep water test of the Ultra Clean CTD (UCC) water sampling bottles has proven to be very useful. Some faults have been not been seen before and recommendations for repair or correction could be given. In total some 10 tests were performed. One of the unknown big surprises was the temperature expansion of the material (pvdf) used. The bottle was no longer under pressure during a shallow cast, because the material expanded 0.003 m when passing through the near-surface thermocline, which is very strong (>15°C) near the equator. Another undisclosed problem encountered was the capturing of air in the bottle, so that the upper lid no longer opened under water. This was solved by inserting an air release valve on the lid. Finally, the bottles obtained a new mount. After these modifications, the system performed excellent during deep casts (Fig. 12).


Hard Lid


Air release


New mount


Release valve

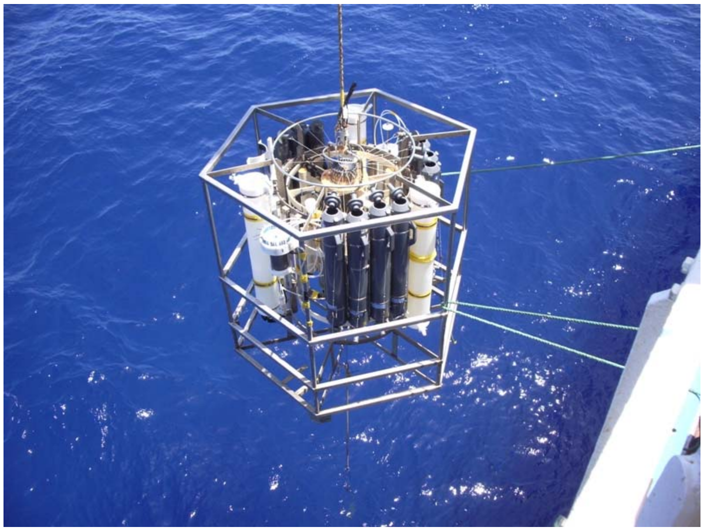


Figure 12. Future large volume samplers (white pipes) mounted on a standard CTD-Rosette frame for deep-ocean testing.

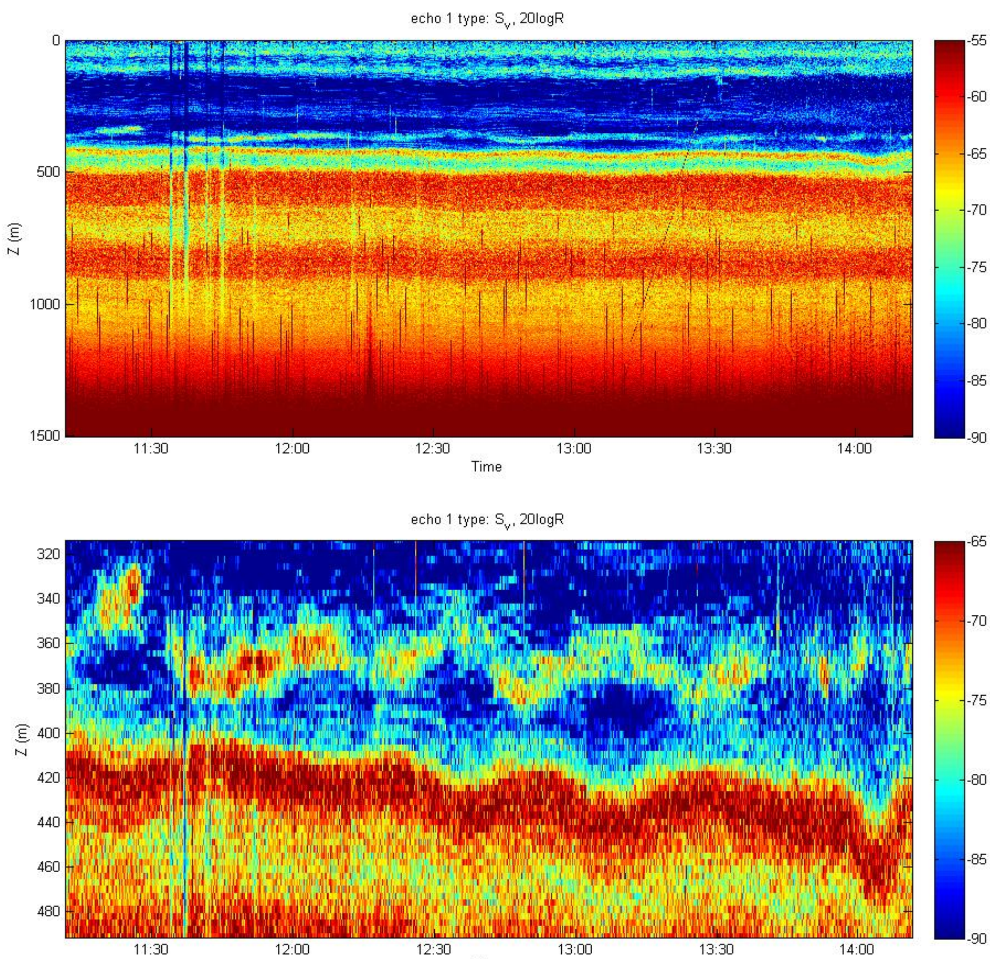


Figure 13. EK500, first successful capture of data: Upper panel: 3-h portion over full depth during yoyo-CTD station. Lower: Mode-2 High-frequency internal waves near 400 m.

*f. EK-500 (*by M. Mercier*)*

For the first time, SIMRAD EK-500 acoustic echo data were successfully downloaded in electronic form. An Ifremer software package was briefly tested, but it was found more convenient to use Matlab for capturing the data via an RS232 link. The protocol for setting up the data collection is in Appendix D. A range of about 1200 m of good data can be reached (Fig. 13). The echo-data show up- and downward zooplankton motions, the passing of the CTD-package, and, in the 3-h examples given: internal waves. These waves have typical periods up to 30 minutes, they mainly move layers far-apart in a more or less synchronous fashion up and down ('mode-1'), but occasionally in a completely asynchronous fashion (mode-2), across some 50 m in the vertical (Fig. 13b). As noticed in the thermistor string data, the form of the waves varies continuously.

*g. Seismic observations of internal waves (*by L. Gostiaux*)*

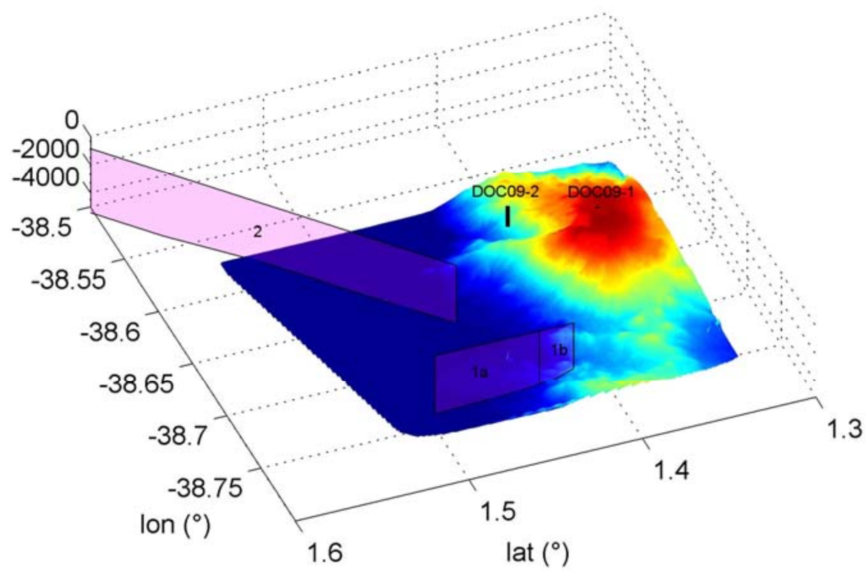


Figure 14. 3D view of seamount and two short-term mooring locations. The two different seismic lines are indicates by the shaded areas. During transect 2 a thermistor string was towed simultaneously.

The use of seismics to explore the horizontal scales of thermohaline structures in the oceans has become a challenging technique during the last five years; sound reflects on temperature discontinuities, and the reflected acoustic signal is susceptible to be recorded using seismic equipment. The horizontal resolution (of the order of 10 m) of the system allows resolution of features never explored before in such details, such as horizontal wavelengths of internal waves, with the notion of potential Doppler shifting.

In order to study the time variability of the thermal structure and to get internal waves signature, we successively surveyed the same section back and forth every 4 hours during 20 hours. We used the high resolution source of the NIOZ: five gun array, 20+10+40+10+20=100ci, cubic inches, in total. This seismic transect, line 1, was 25 km long, above a slightly sloping bottom and close to an instrumented seamount (Fig. 14). Each passage was split in two seismic transects (1a and 1b) so as to adjust shooting time to the water depth. For respective sailing speed of 3.4 and 3.8 knots, the shooting times were of 12.0 and 10.8s, keeping a 21m (2 groups) shoot interval.

Processing could not be performed onboard, but at least, using the 32bit fixed point SEGY output format of Geo-trace, a good compatibility with both Seismic Unix and SegyMat free software was achieved. The acquisitions were obtained in good weather conditions and without major difficulties.

Concerning the technical aspects :

- only two birds could be used on the streamer, the third one still suffers pressure sensor failure
- it was verified that hydrophones are grouped by 11, not 10. Group spacing is correct at 10.5m
- the new GPS was successfully connected to GEOTRACES, the loose power supply cable - repaired, yet post-processing showed that logging was irregular (Fig. 15)
- the new umbilical works well.

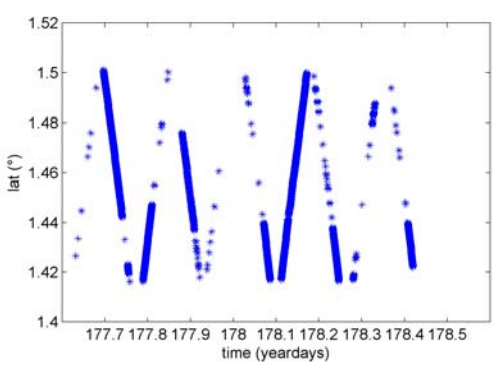


Figure 15. North-South path along seismic line 1(a and b) from the GPS; the overpassing is regular yet the GPS signal is not refreshed regularly.

A few days later, a one way seismic transect, line 2, was shot above the flat Ceara abyssal plain (Fig. 14), at a ship speed of 3.4 knots and using a 12 s shooting time. Simultaneously, 50 NIOZ4 thermistors were attached to a towed cable held from the side frame. Thermistors recorded temperature at a rate of 2Hz between 180 and 300 m. This is the TOW09 dataset (Fig. 16). The cable ended with a 750 kg weight, and a synchronizer with embedded pressure sensor was attached to its end, so as to compensate the temperature signal for the effects of towed cable oscillations. Also, we digitized the EK500 38-kHz echosounder signal during this transect, with the hope that comparison of the three datasets will reveal quantitative information on temperature variations and internal waves.

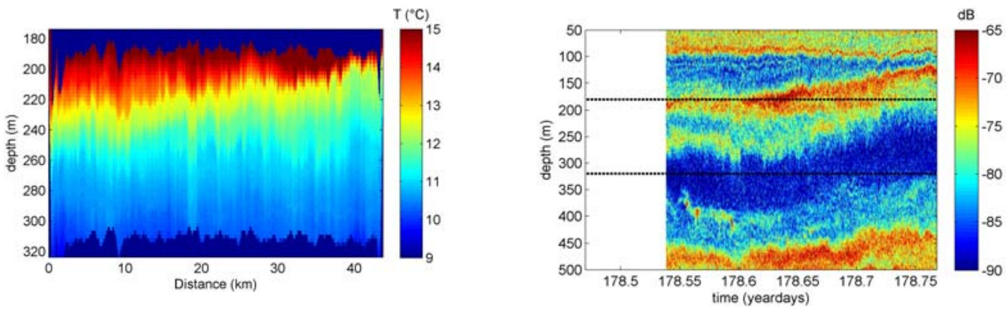


Figure 16. Left : temperature signal from the towed thermistor string along Seismic transect #2; cable vertical oscillations have been preliminarily compensated using the pressure signal recorded on the synchronizer. This compensation still needs improvement.
Right : EK500 signal during the same period; the two dashed lines indicate the approximate towing depth interval.

The NIOZ4 thermistors also have an acceleration sensor embedded. At rest, it measures the Earth acceleration and its direction gives the inclination of the sensor. In the case of a towed instrument, the vertical integration of the inclination of each sensor helps to reconstruct the shape of the mooring; yet, due to the vibration of the cable, only average data could be retrieved, the instantaneous data being too noisy (vibration induces accelerations as strong as 1.0g). The reconstructed shape of TOW09 string is given on a 1:1 scale in Fig. 17.

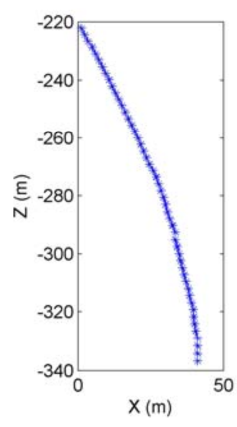


Figure 17. Shape of the towed line TOW09 inferred from the embedded tilt sensor data at each of the NIOZ4 sensors and averaged over the deployment time.

8. Achnowledgments

On behalf of all participants, I would like to thank captain Kees de Graaff and the crew of R.V. Pelagia for the very pleasant cooperation. Funding by the Netherlands Organization for the advancement of Scientific Research and BSIK is gratefully acknowledged.

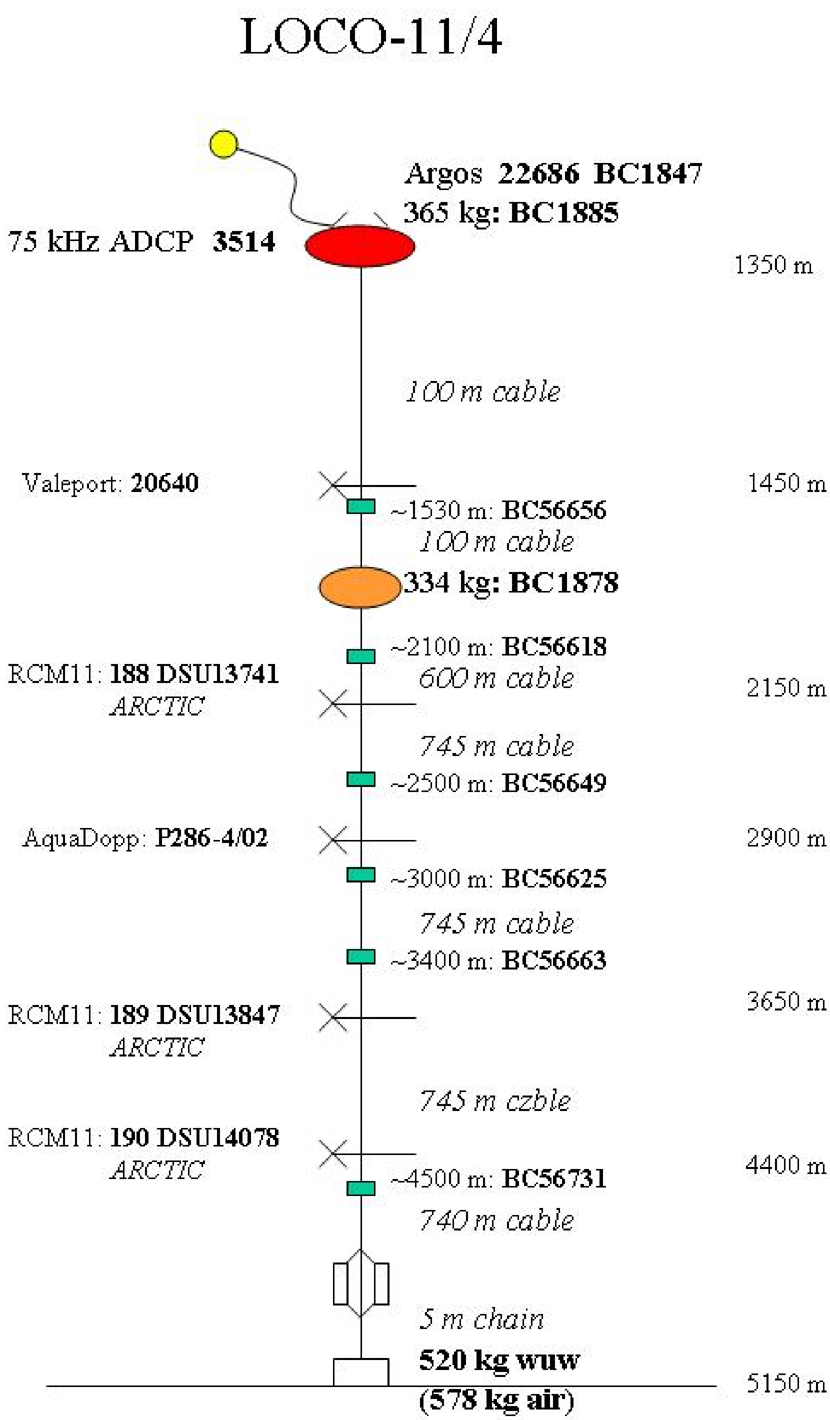
August, November 2009,

Hans van Haren

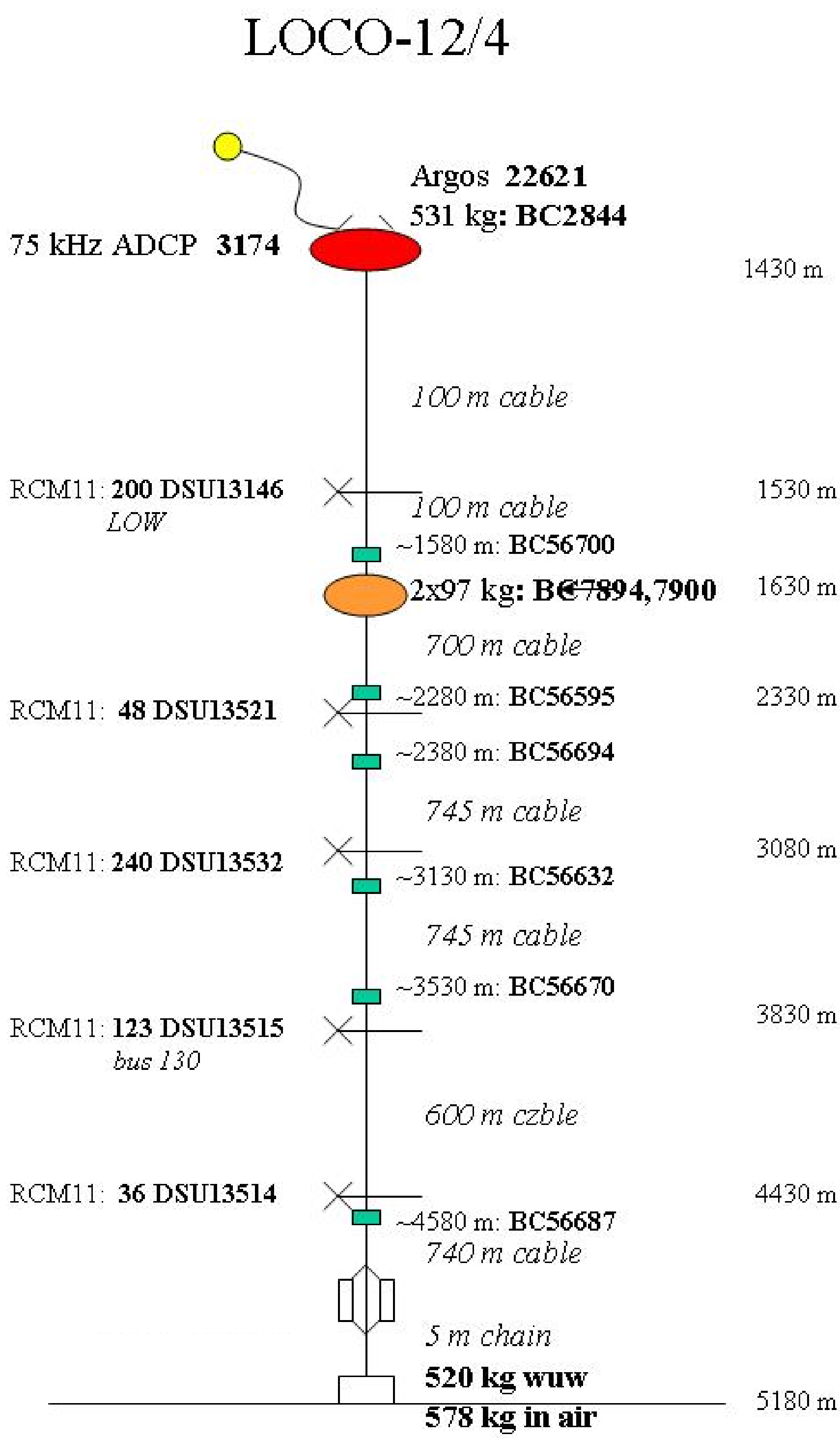
Hiding (K. Kikkert)

Appendix A Mooring diagrams LOCO-IW09 (*by T. Hillebrand & Dept. MTM*)

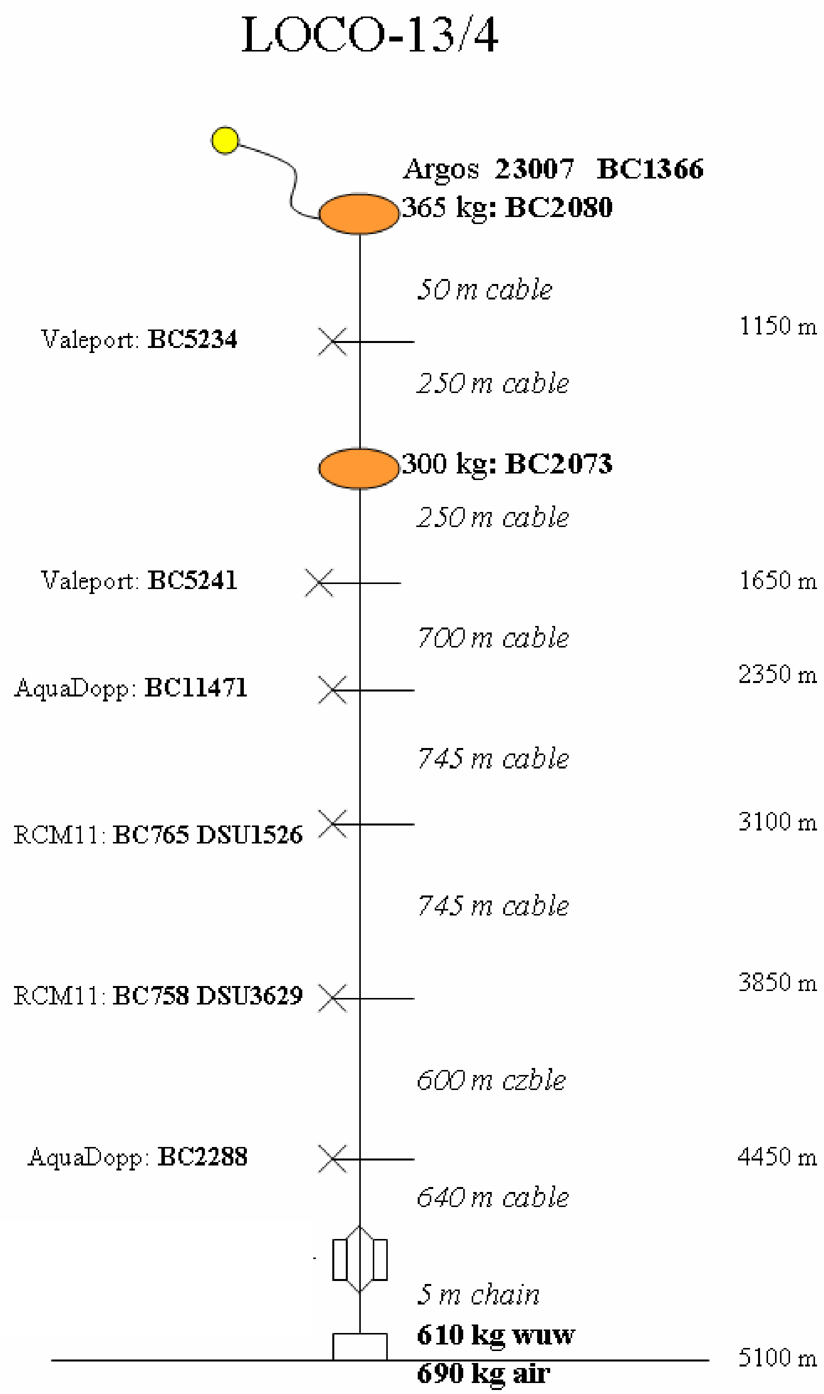
LOCO11/4



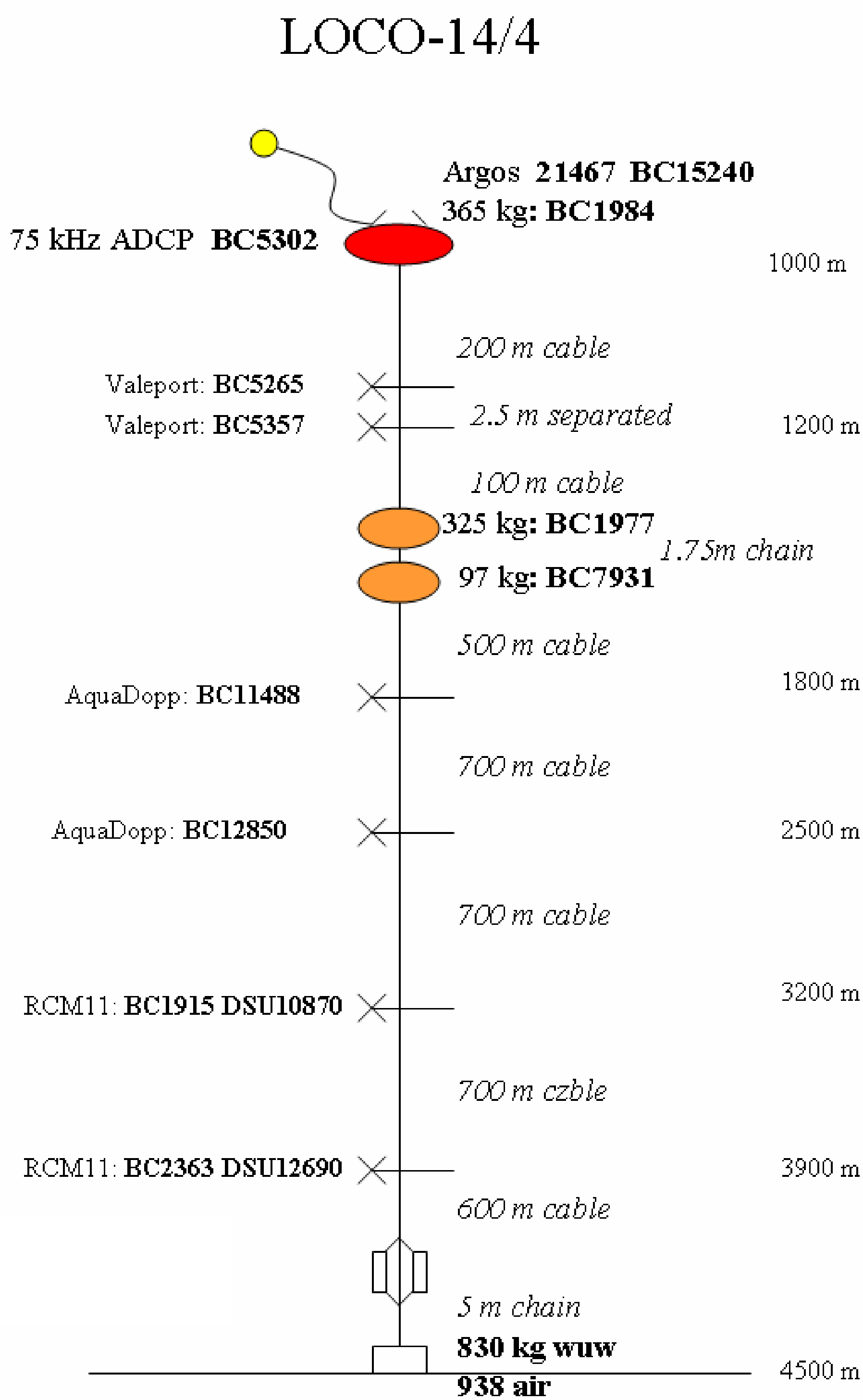
LOCO12/4


LOCO-12/4
Argos 22621
531 kg: BC2844
75 kHz ADCP 3174
1430 m
100 m cable
RCM11: 200 DSU13146
LOW
100 m cable
1530 m
~1580 m: BC56700
2x97 kg: BC7894,7900
1630 m
700 m cable
~2280 m: BC56595
RCM11: 48 DSU13521
2330 m
~2380 m: BC56694
745 m cable
RCM11: 240 DSU13532
3080 m
~3130 m: BC56632
745 m cable
~3530 m: BC56670
RCM11: 123 DSU13515
bus 130
3830 m
600 m czble
RCM11: 36 DSU13514
4430 m
~4580 m: BC56687
740 m cable
5 m chain
520 kg wuw
578 kg in air
5180 m

LOCO13/4

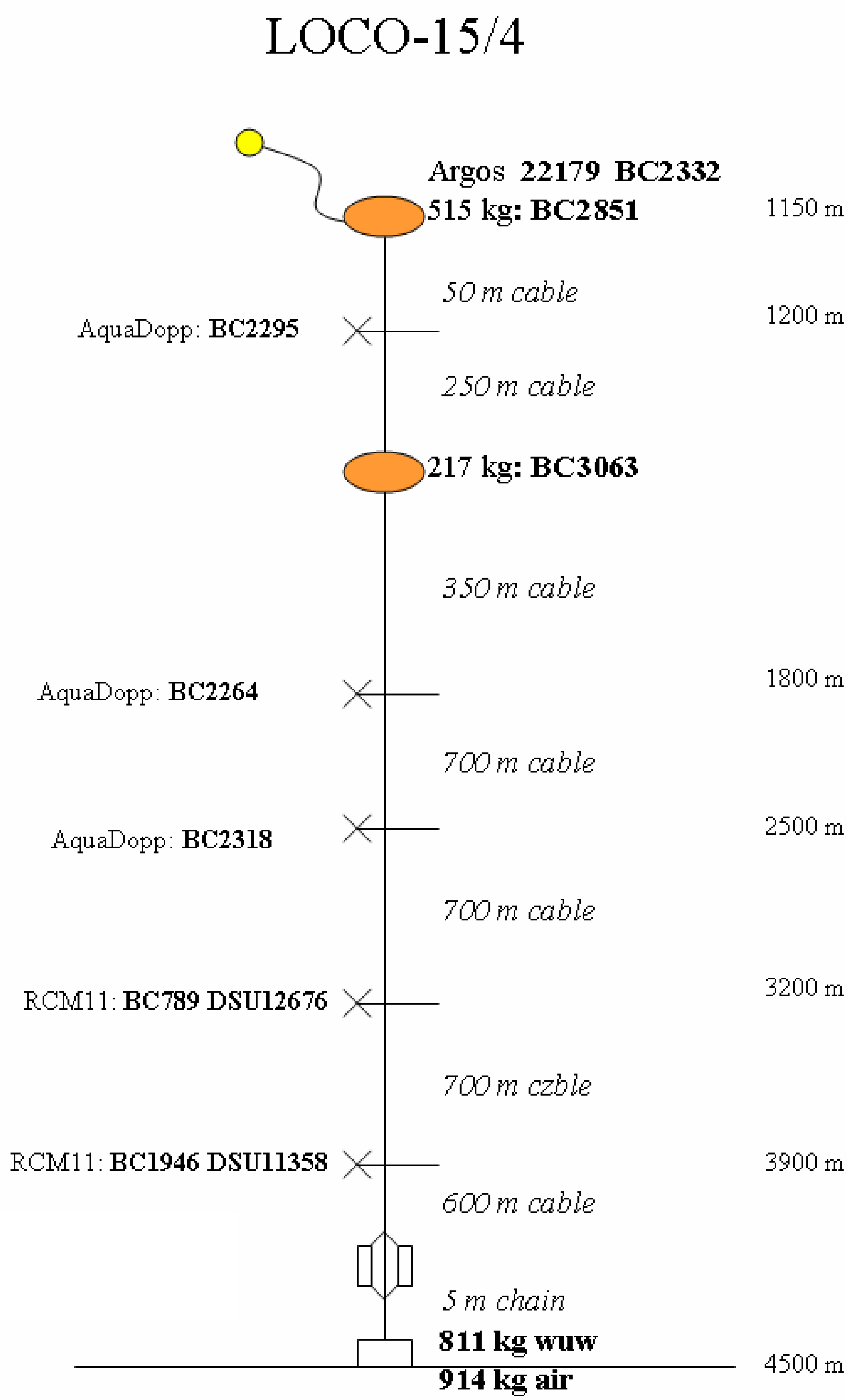

LOCO-13/4
Argos 23007 BC1366
365 kg: BC2080
50 m cable
Valeport: BC5234
1150 m
250 m cable
300 kg: BC2073
250 m cable
Valeport: BC5241
1650 m
700 m cable
AquaDopp: BC11471
2350 m
745 m cable
RCM11: BC765 DSU1526
3100 m
745 m cable
RCM11: BC758 DSU3629
3850 m
600 m czble
AquaDopp: BC2288
4450 m
640 m cable
5 m chain
610 kg wuw
690 kg air
5100 m

LOCO14/4

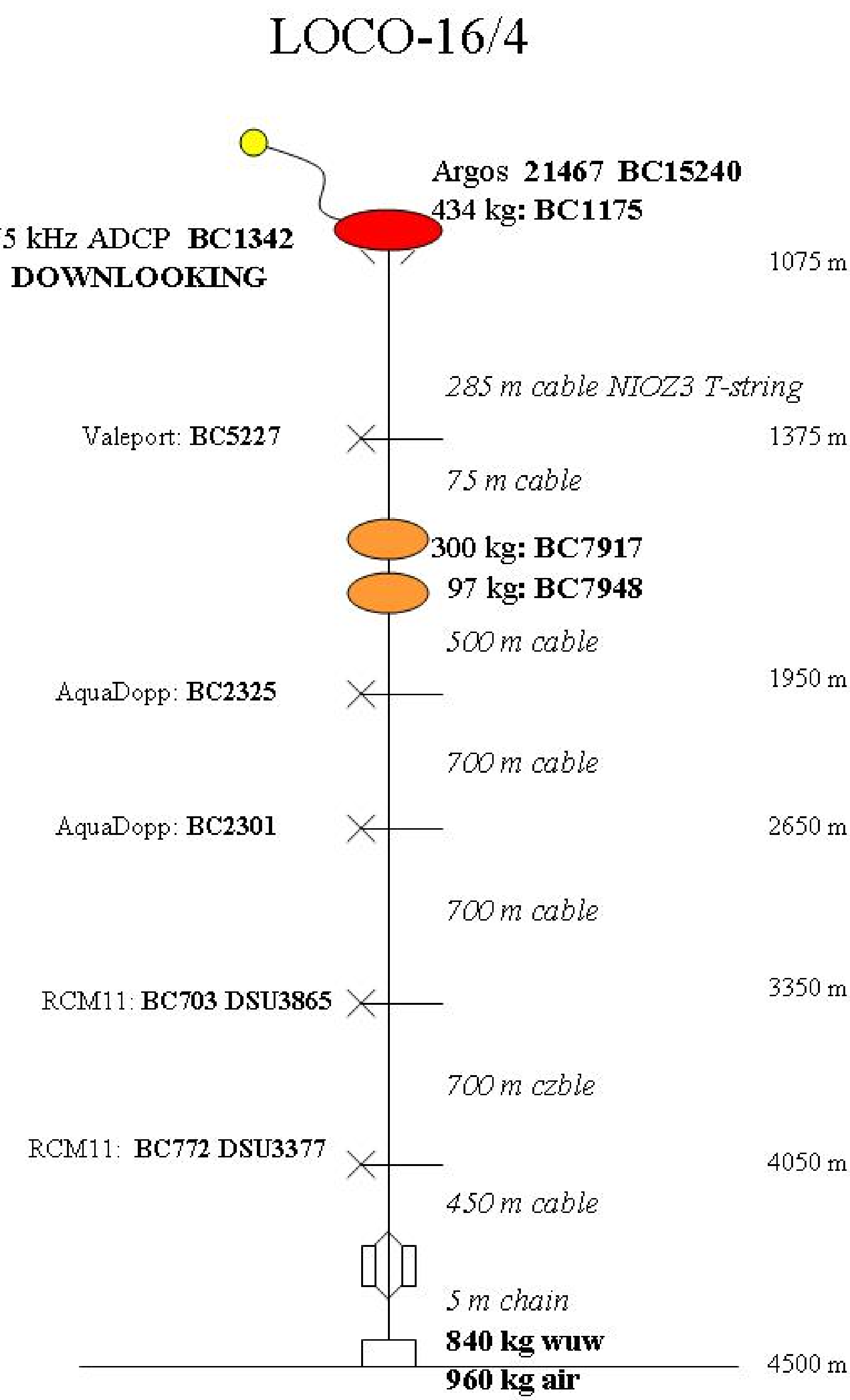


LOCO-14/4
Argos 21467 BC15240
365 kg: BC1984
75 kHz ADCP BC5302
1000 m
200 m cable
Valeport: BC5265
Valeport: BC5357
2.5 m separated
1200 m
100 m cable
325 kg: BC1977
1.75m chain
97 kg: BC7931
500 m cable
AquaDopp: BC11488
1800 m
700 m cable
AquaDopp: BC12850
2500 m
700 m cable
RCM11: BC1915 DSU10870
3200 m
700 m czble
RCM11: BC2363 DSU12690
3900 m
600 m cable
5 m chain
830 kg wuw
938 air
4500 m

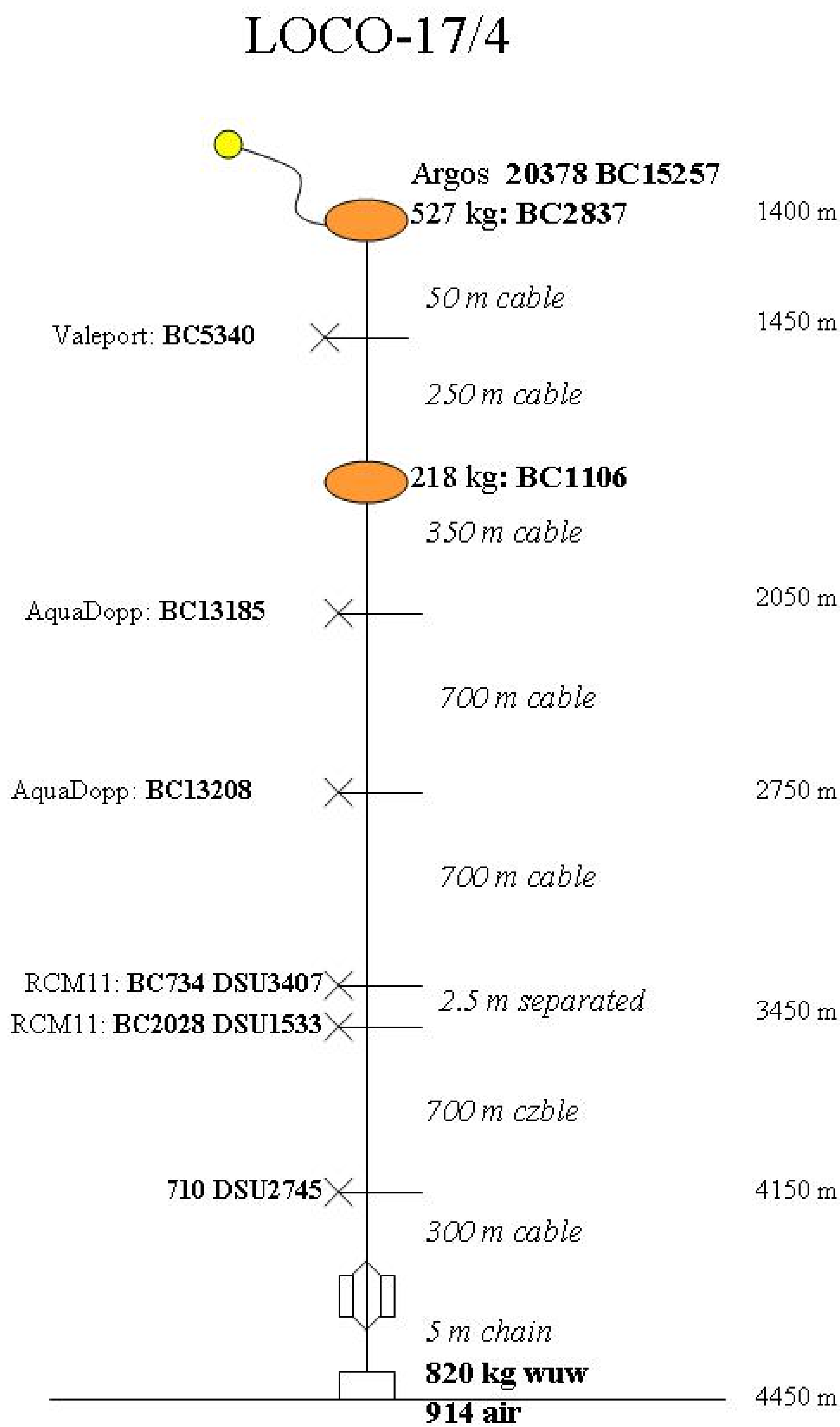
LOCO15/4


LOCO-15/4
Argos 22179 BC2332
515 kg: BC2851
1150 m
50 m cable
1200 m
AquaDopp: BC2295
250 m cable
217 kg: BC3063
350 m cable
AquaDopp: BC2264
1800 m
700 m cable
AquaDopp: BC2318
2500 m
700 m cable
RCM11: BC789 DSU12676
3200 m
700 m czble
RCM11: BC1946 DSU11358
3900 m
600 m cable
5 m chain
811 kg wuw
914 kg air
4500 m

LOCO16/4

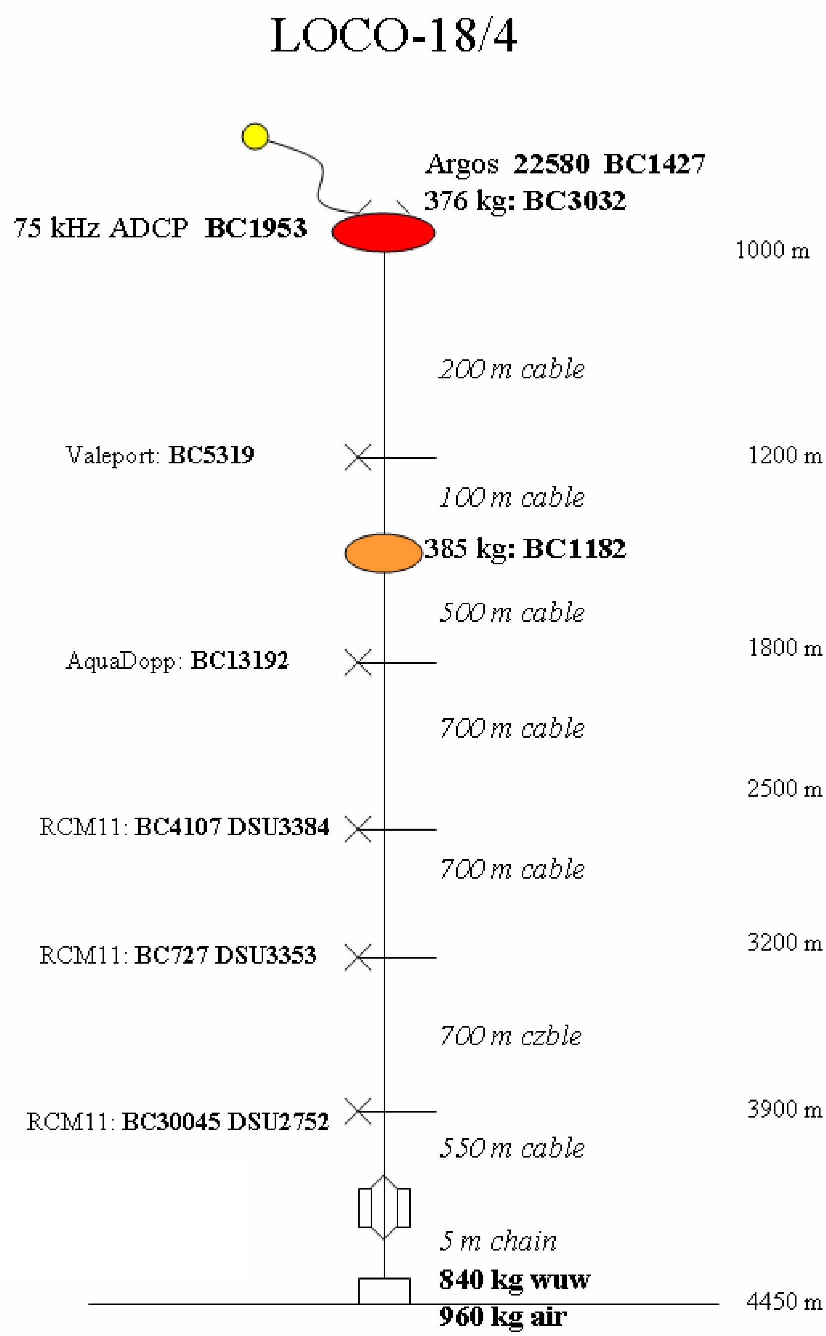

LOCO-16/4
Argos 21467 BC15240
434 kg: BC1175
75 kHz ADCP BC1342
DOWNLOOKING
1075 m
285 m cable NIOZ3 T-string
Valeport: BC5227
1375 m
75 m cable
300 kg: BC7917
97 kg: BC7948
500 m cable
1950 m
AquaDopp: BC2325
700 m cable
AquaDopp: BC2301
2650 m
700 m cable
3350 m
RCM11: BC703 DSU3865
700 m czble
RCM11: BC772 DSU3377
4050 m
450 m cable
5 m chain
840 kg wuw
960 kg air
4500 m

LOCO17/4



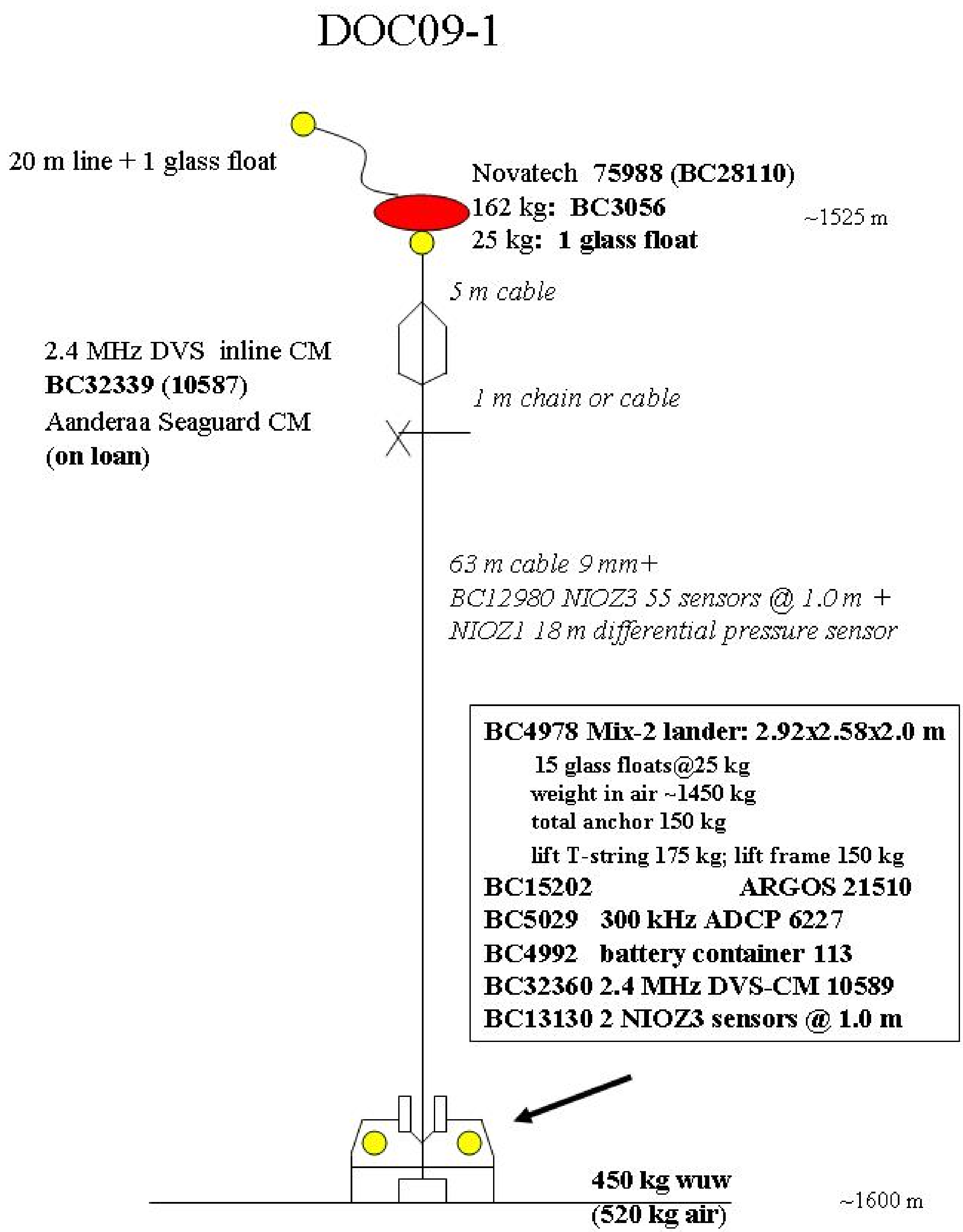
LOCO-17/4
Argos 20378 BC15257
527 kg: BC2837
1400 m
50 m cable
Valeport: BC5340
1450 m
250 m cable
218 kg: BC1106
350 m cable
AquaDopp: BC13185
2050 m
700 m cable
AquaDopp: BC13208
2750 m
700 m cable
RCM11: BC734 DSU3407
RCM11: BC2028 DSU1533
2.5 m separated
3450 m
700 m czble
710 DSU2745
4150 m
300 m cable
5 m chain
820 kg wuw
914 air
4450 m

LOCO18/4



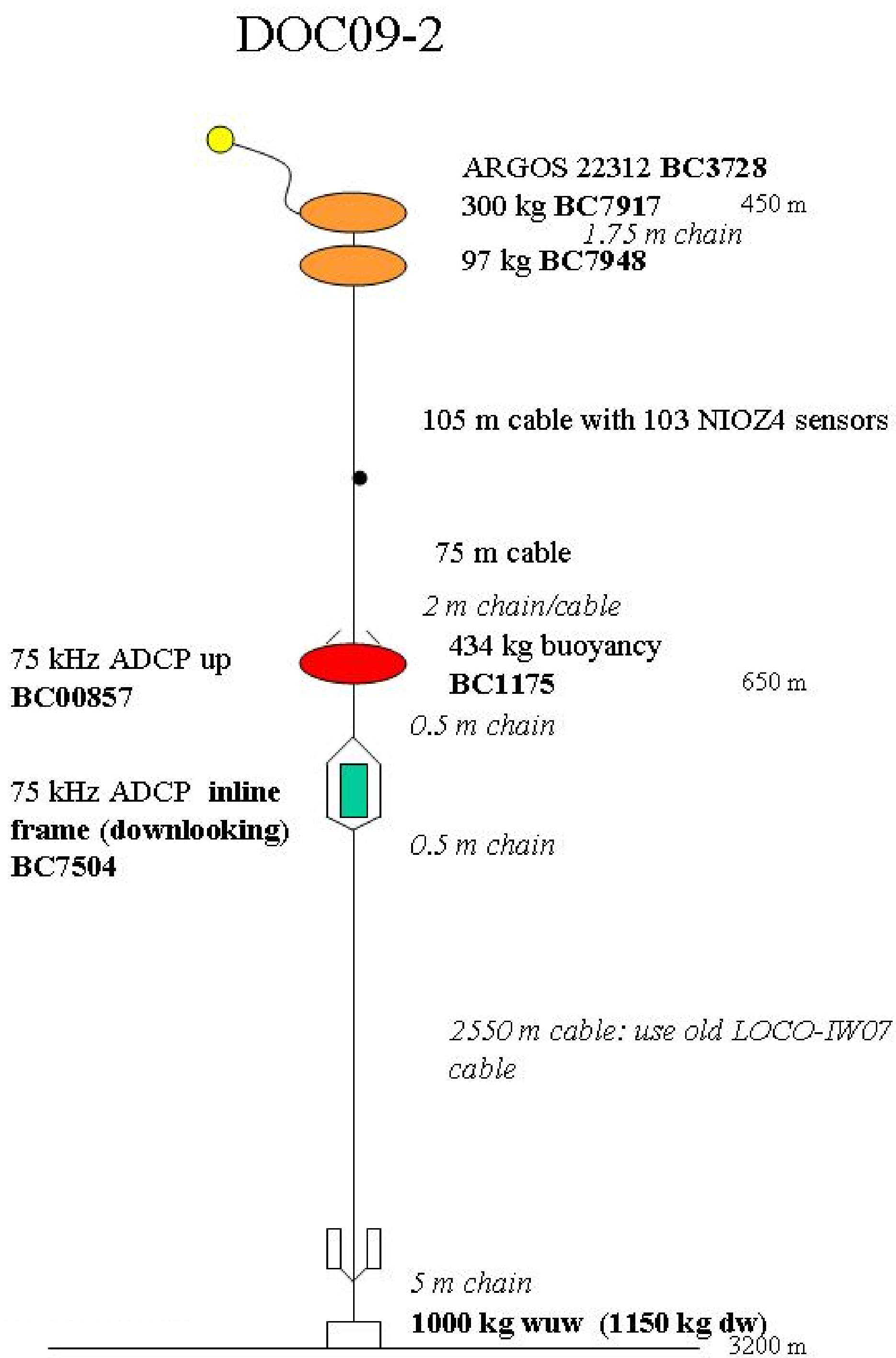
LOCO-18/4
Argos 22580 BC1427
376 kg: BC3032
75 kHz ADCP BC1953
1000 m
200 m cable
Valeport: BC5319
1200 m
100 m cable
385 kg: BC1182
500 m cable
AquaDopp: BC13192
1800 m
700 m cable
2500 m
RCM11: BC4107 DSU3384
700 m cable
3200 m
RCM11: BC727 DSU3353
700 m czble
RCM11: BC30045 DSU2752
3900 m
550 m cable
5 m chain
840 kg wuw
960 kg air
4450 m

DOC09_1



DOC09-1
20 m line + 1 glass float
Novatech 75988 (BC28110)
162 kg: BC3056
25 kg: 1 glass float
~1525 m
5 m cable
2.4 MHz DVS inline CM
BC32339 (10587)
Aanderaa Seaguard CM
(on loan)
1 m chain or cable
63 m cable 9 mm+
BC12980 NIOZ3 55 sensors @ 1.0 m +
NIOZ1 18 m differential pressure sensor
BC4978 Mix-2 lander: 2.92x2.58x2.0 m
15 glass floats@25 kg
weight in air ~1450 kg
total anchor 150 kg
lift T-string 175 kg; lift frame 150 kg
BC15202 ARGOS 21510
BC5029 300 kHz ADCP 6227
BC4992 battery container 113
BC32360 2.4 MHz DVS-CM 10589
BC13130 2 NIOZ3 sensors @ 1.0 m
450 kg wuw
(520 kg air)
~1600 m

DOC09_2


DOC09-2
ARGOS 22312 BC3728
300 kg BC7917
450 m
1.75 m chain
97 kg BC7948
105 m cable with 103 NIOZ4 sensors
75 m cable
2 m chain/cable
75 kHz ADCP up
BC00857
434 kg buoyancy
BC1175
650 m
0.5 m chain
75 kHz ADCP inline
frame (downlooking)
BC7504
0.5 m chain
2550 m cable: use old LOCO-IW07
cable
5 m chain
1000 kg wuw (1150 kg dw)
3200 m

Appendix B Summary of seismic lines (*by L. Gostiaux*)

Line	Lat_start	Lat_end	Lon_start	Lon_end	Course	Speed (kn)	Shooting(ms)
64PE308_d	1°25.62'	1°26.59'	-38°45.00'	-38°45.00'	0°	3.8	10800
64PE308_e	1°26.69'	1°29.63'	-38°45.00'	-38°45.00'	0°	3.4	12000
64PE308_f	1°30.07'	1°26.53'	-38°45.00'	-38°45.00'	180°	3.4	12000
64PE308_g	1°26.53'	1°24.97'	-38°45.00'	-38°45.00'	180°	3.8	10800
64PE308_h	1°24.97'	1°26.85'	-38°45.00'	-38°45.00'	0°	3.8	10800
64PE308_i	1°26.85'	1°29.83'	-38°45.00'	-38°45.00'	0°	3.4	12000
64PE308_j	1°30.01'	1°26.22'	-38°45.00'	-38°45.00'	180°	3.4	12000
64PE308_k	1°26.21'	1°25.04'	-38°45.00'	-38°45.00'	180°	3.8	10800
64PE308_l	1°25.01'	1°26.18'	-38°45.00'	-38°45.00'	0°	3.8	10800
64PE308_m	1°26.18'	1°27.63'	-38°45.00'	-38°45.00'	0°	3.4	12000
64PE308_n	1°29.87'	1°26.60'	-38°45.00'	-38°45.00'	180°	3.4	12000
64PE308_o	1°26.41'	1°25.01'	-38°45.00'	-38°45.00'	180°	3.8	10800
64PE308_p	1°25.00'	1°26.94'	-38°45.00'	-38°45.00'	0°	3.8	10800
64PE308_q	1°26.57'	1°29.99'	-38°45.00'	-38°45.00'	0°	3.4	12000
65PE308_r	1°30.00'	1°26.53'	-38°45.00'	-38°45.00'	180°	3.4	12000
66PE308_s	1°26.29'	1°24.97'	-38°45.00'	-38°45.00'	180°	3.8	10800
67PE308_t	1°24.97'	1°25.63'	-38°45.00'	-38°45.00'	0°	3.8	10800
68PE308_u	1°25.63'	1°29.27'	-38°45.00'	-38°45.00'	0°	3.4	12000
69PE308_v	1°29.27'	1°26.84'	-38°45.00'	-38°45.00'	180°	3.4	12000
70PE308_w	1°26.41'	1°25.02'	-38°45.00'	-38°45.00'	180°	3.8	10800
71PE308_x	1°27.44'	1°29.67'	-38°41.02'	-38°38.38'	50°	3.4	10800
64PE308_y	1°29.67'	1°32.99'	-38°38.38'	-38°34.54'	50°	3.4	12000
64PE308_z	1°33.10'	1°36.87'	-38°34.41'	-38°29.87'	50°	3.4	12000
64PE308_aa	1°36.87'	1°38.33'	-38°29.88'	-38°28.10'	50°	3.4	10800

Appendix C Cruise summary of stations (activities) of LOCO-IW09 (*M. Hiehle*)

Station	Cast	Type	Event	date time	Latitude (dec. degr.)	Longitude (dec. degr.)	Depth (m)	Remark
1	1	CTD_therm +watersamplers	Begin	Jun 22 2009 21:15:18	-0.17412	-37.55877	4439	thermistors calbration
1	1	CTD_therm +watersamplers	Bottom	Jun 22 2009 22:37:11	-0.17403	-37.55905	4439	2 new bottles not closed
1	1	CTD_therm +watersamplers	End	Jun 23 2009 00:38:35	-0.17387	-37.55930	4439	
1	2	CTD_therm +watersamplers	Begin	Jun 23 2009 01:08:38	-0.13130	-37.56917	4414	thermistors calbration
1	2	CTD_therm +watersamplers	Bottom	Jun 23 2009 01:15:41	-0.13090	-37.56945	4414	Stopped at 350 m
1	2	CTD_therm +watersamplers	End	Jun 23 2009 01:49:05	-0.13085	-37.56832	4414	
2	1	Mooring recovery	released	Jun 23 2009 10:15:56	0.94468	-37.90127	4475	LOCO 16/4
2	1	Mooring recovery	Begin	Jun 23 2009 10:38:19	0.95140	-37.90458	4475	
2	1	Mooring recovery	End	Jun 23 2009 13:46:04	0.97723	-37.89828	4469	
3	1	Mooring deployment	Begin	Jun 23 2009 19:45:24	1.36135	-38.64307	1634	DOC 09-1 released
3	1	Mooring deployment	End	Jun 23 2009 19:46:33	1.36193	-38.64312	1640	
4	1	Mooring deployment	Begin	Jun 23 2009 21:05:40	1.41702	-38.64653	4525	
4	1	Mooring deployment	End	Jun 23 2009 22:42:58	1.41058	-38.62363	3263	DOC 09-2 released
5	1	Mooring recovery	released	Jun 24 2009 11:53:18	0.60323	-36.76403		LOCO 15/4
5	1	Mooring recovery	Begin	Jun 24 2009 12:18:19	0.60123	-36.76082		
5	1	Mooring recovery	End	Jun 24 2009 13:59:26	0.62955	-36.75322	4506	
6	1	Mooring recovery	released	Jun 24 2009 18:34:02	0.01643	-36.97905		LOCO 14/4
6	1	Mooring recovery	Begin	Jun 24 2009 19:00:38	0.00060	-36.99412		
6	1	Mooring recovery	End	Jun 24 2009 20:38:16	-0.00077	-36.97553	4517	
7	1	CTD_Thermistor	Begin	Jun 24 2009 21:03:15	0.00102	-36.97455	4520	+ watersamples
7	1	CTD_Thermistor	Bottom	Jun 24 2009 21:23:09	0.00137	-36.97403		
7	1	CTD_Thermistor	End	Jun 24 2009 22:03:05	0.00090	-36.97505		
8	1	CTD	Begin	Jun 25 2009 14:17:33	1.38675	-38.63343	2243	YoYo Station off DOC Moorings
8	1	CTD	End	Jun 26 2009 15:33:38	1.38752	-38.62910	2231	
9	1	MultiBeam begin	Begin	Jun 26 2009 15:35:51	1.38737	-38.62935	2231	
10	1	MultiBeam end	End	Jun 26 2009 16:33:19	1.36492	-38.634	1664	
11	1	Seismics SOL	Begin	Jun 26 2009 16:33:20	1.36492	-38.63400	1664	Test thermistor towing 2 lines 600 kg weight
12	1	Seismics EOL	End	Jun 26 2009 17:23:31	1.38182	-38.62885	2128	end test
13	1	Seismics SOL	Begin	Jun 26 2009 17:28:26	1.38155	-38.62797	2134	test 2 eight at 200m
14	1	Seismics EOL	End	Jun 26 2009 17:47:07	1.37497	-38.62985	2030	End test
15	1	Seismics SOL	Begin	Jun 26 2009 17:50:59	1.37498	-38.62977	2006	test 1000kg op 200m
16	1	Seismics EOL	End	Jun 26 2009 18:17:07	1.37223	-38.62950	2073	End test
17	1	Seismics SOL	Begin	Jun 26 2009 19:52:35	1.32887	-38.73577		Test
18	1	Seismics EOL	End	Jun 26 2009 23:05:14	1.43592	-38.74785		
19	1	CTD	Begin	Jun 27 2009 00:21:40	1.41655	-38.66663	3000	YoYo
19	1	CTD	End	Jun 27 2009 12:02:18	1.41673	-38.66582	3006	
20	1	Seismics SOL	Begin	Jun 27 2009 13:09:52	1.39957	-38.74987	3304	
21	1	Seismics EOL	End	Jun 27 2009 13:50:05	1.34992	-38.75005	3207	
22	1	Seismics SOL	Begin	Jun 27 2009 14:10:54	1.34997	-38.75003	3310	line A
23	1	Seismics EOL	End	Jun 27 2009 14:28:22	1.37170	-38.75015	2945	end line A
24	1	Seismics SOL	Begin	Jun 27 2009 14:29:37	1.37342	-38.75023	2853	line B
25	1	Seismics EOL	End	Jun 27 2009 14:38:35	1.38612	-38.74992	3060	end line B
26	1	Seismics SOL	Begin	Jun 27 2009 14:40:16	1.38832	-38.74977	3121	line C
27	1	Seismics EOL	End	Jun 27 2009 15:06:34	1.42182	-38.74995	3426	end line C
28	1	Seismics SOL	Begin	Jun 27 2009 15:08:36	1.42420	-38.74980	4115	Line D
29	1	Seismics EOL	End	Jun 27 2009 15:37:39	1.45373	-38.74997	3871	end line D
30	1	Seismics SOL	Begin	Jun 27 2009 15:40:25	1.45660	-38.74997	3896	Line E

31	1	Seismics EOL	End	Jun 27 2009 16:26:11	1.50050	-38.75008	4079	end line E
32	1	Seismics SOL	Begin	Jun 27 2009 16:42:53	1.50187	-38.74943	4085	Line F
34	1	MultiBeam end	End	Jun 27 2009 17:03:33	1.48323	-38.75003	4006	
35	1	Seismics EOL	End	Jun 27 2009 17:47:15	1.44195	-38.74988	3914	end line F
36	1	Seismics SOL	Begin	Jun 27 2009 17:48:45	1.44045	-38.74993	3914	line G
37	1	Seismics EOL	End	Jun 27 2009 18:12:17	1.41587	-38.74972	3439	end line G
37	2	Seismics SOL	Begin	Jun 27 2009 19:00:21	1.42022	-38.75002	3445	Start line H
37	3	Seismics EOL	End	Jun 27 2009 19:28:21	1.44917	-38.74990	3847	End of line H
37	4	Seismics SOL	Begin	Jun 27 2009 19:31:23	1.45210	-38.74968	3865	Start of line I
37	5	Seismics EOL	End	Jun 27 2009 20:22:45	1.50113	-38.75005	4085	End of line I
37	6	Seismics SOL	Begin	Jun 27 2009 20:43:16	1.50018	-38.75018	4085	Start of line J
37	7	Seismics EOL	End	Jun 27 2009 21:50:20	1.43633	-38.74990	3591	End of line J
37	8	Seismics SOL	Begin	Jun 27 2009 21:51:41	1.43497	-38.74997	3664	Start line K
37	9	Seismics EOL	End	Jun 27 2009 22:09:26	1.41618	-38.74997	3445	
37	10	Seismics SOL	Begin	Jun 27 2009 22:29:50	1.41705	-38.74897	3536	Start Line L
37	11	Seismics EOL	End	Jun 27 2009 22:53:26	1.44238	-38.74990	3829	
37	12	Seismics SOL	Begin	Jun 27 2009 22:54:44	1.44367	-38.74988	3835	Start Line M
37	13	Seismics EOL	End	Jun 27 2009 23:19:22	1.46815	-38.74985	3939	
37	14	Seismics SOL	Begin	Jun 28 2009 00:39:19	1.49962	-38.74925	4085	Start Line N
37	15	Seismics EOL	End	Jun 28 2009 01:41:41	1.44068	-38.74985	3847	
37	16	Seismics SOL	Begin	Jun 28 2009 01:42:35	1.43983	-38.74992	3847	Start Line O
37	17	Seismics EOL	End	Jun 28 2009 02:05:33	1.41565	-38.74980	3292	End line O
37	18	Seismics SOL	Begin	Jun 28 2009 02:41:11	1.41665	-38.74922	3451	Start line P
37	19	Seismics EOL	End	Jun 28 2009 03:05:47	1.44220	-38.75030	3628	end line P
37	20	Seismics SOL	Begin	Jun 28 2009 03:19:44	1.45537	-38.74927	3890	start line Q
37	21	Seismics EOL	End	Jun 28 2009 04:08:14	1.50018	-38.74997	4079	end line Q
37	22	Seismics SOL	Begin	Jun 28 2009 04:29:50	1.50020	-38.75133	4085	start line R
37	23	Seismics EOL	End	Jun 28 2009 05:32:34	1.44070	-38.75023	3865	end line R
37	24	Seismics SOL	Begin	Jun 28 2009 05:35:11	1.43802	-38.75028	3865	start line S
37	25	Seismics EOL	End	Jun 28 2009 05:56:05	1.41585	-38.75012	3439	end line S
37	26	Seismics SOL	Begin	Jun 28 2009 06:42:35	1.41650	-38.74878	3469	Start line T
37	27	Seismics EOL	End	Jun 28 2009 07:10:38	1.44398	-38.75018	3829	End line T
37	28	Seismics SOL	Begin	Jun 28 2009 07:13:22	1.44685	-38.74993	3829	Start line U
37	29	Seismics EOL	End	Jun 28 2009 08:11:38	1.50068	-38.75025	4079	End line U
37	30	Seismics SOL	Begin	Jun 28 2009 08:45:10	1.49990	-38.75068	4085	Start line V
37	31	Seismics EOL	End	Jun 28 2009 09:44:45	1.44292	-38.75005	3926	End line V
37	32	Seismics SOL	Begin	Jun 28 2009 09:48:19	1.43930	-38.75018	3926	Start line W
37	33	Seismics EOL	End	Jun 28 2009 10:10:01	1.41650	-38.75002	3298	
38	1	Towed Thermistor BEGIN	Begin	Jun 28 2009 11:21:49	1.39952	-38.74988	3280	
38	2	Seismics SOL	Begin	Jun 28 2009 12:56:24	1.45768	-38.68338	3957	end line X
38	3	Seismics EOL	End	Jun 28 2009 14:07:13	1.50243	-38.63060	4067	start line Y
38	4	Seismics SOL	Begin	Jun 28 2009 15:24:39	1.55153	-38.57380	4109	end line Y
38	5	Seismics SOL	Begin	Jun 28 2009 15:25:28	1.55205	-38.57318	4109	start line Z
38	6	Seismics EOL	End	Jun 28 2009 17:06:32	1.61462	-38.49783	4201	end line Z
38	7	Seismics SOL	Begin	Jun 28 2009 17:06:50	1.61480	-38.49763	4201	start line AA
38	8	Seismics EOL	End	Jun 28 2009 17:54:38	1.64355	-38.46275	4243	end line AA
38	9	Towed Thermistor END	End	Jun 28 2009 18:23:35	1.65945	-38.44292	4250	
39	1	Mooring recovery	released	Jun 29 2009 09:54:50	2.48748	-38.03510	4451	
39	1	Mooring recovery	Begin	Jun 29 2009 10:32:18	2.50485	-38.03207	4451	LOCO 18/4
39	1	Mooring recovery	End	Jun 29 2009 12:09:30	2.49620	-38.02530	4451	
40	1	Mooring recovery	released	Jun 29 2009 16:02:21	2.01368	-37.68783	4414	LOCO 17/4
40	1	Mooring recovery	Begin	Jun 29 2009 16:37:00	2.00420	-37.68210	4432	

40	1	Mooring recovery	End	Jun 29 2009 17:47:30	1.98962	-37.67087	4426	
41	1	CTD_watersamplers	Begin	Jun 29 2009 18:04:13	1.98878	-37.66915	4426	
41	1	CTD_watersamplers	Bottom	Jun 29 2009 20:30:51	1.98873	-37.66600	4426	
41	1	CTD_watersamplers	End	Jun 29 2009 20:30:53	1.98873	-37.66600	4426	
42	1	Lander recovery	released	Jun 30 2009 09:54:54	1.41093	-38.60772	2993	DOC 09/2
42	1	Lander recovery	Begin	Jun 30 2009 10:14:15	1.41288	-38.61740	3097	
42	1	Lander recovery	End	Jun 30 2009 11:54:47	1.41000	-38.59512	2884	
43	1	Lander recovery	released	Jun 30 2009 12:43:23	1.37120	-38.62647	2000	DOC 09/1
43	1	Lander recovery	Begin	Jun 30 2009 13:29:51	1.36065	-38.62792	2164	
43	1	Lander recovery	End	Jun 30 2009 14:24:06	1.36278	-38.61658	2000	
44	1	CTD_watersamplers	Begin	Jul 04 2009 16:11:22	15.07125	-31.49530	3469	
44	1	CTD_watersamplers	Bottom	Jul 04 2009 16:25:20	15.07130	-31.49923	3469	cast depth 500 m
44	1	CTD_watersamplers	End	Jul 04 2009 16:37:29	15.07057	-31.49960	3469	
45	1	CTD_watersamplers	Begin	Jul 06 2009 15:13:14	21.37633	-28.06368	4567	
45	1	CTD_watersamplers	Bottom	Jul 06 2009 15:23:27	21.37567	-28.06318	4567	cast depth 547
45	1	CTD_watersamplers	End	Jul 06 2009 15:35:40	21.37542	-28.06253	4567	
46	1	CTD_Thermistor	Begin	Jul 07 2009 14:11:22	24.52463	-26.28640	4567	+watersamples cast depth 3500m
46	1	CTD_Thermistor	Bottom	Jul 07 2009 14:53:35	24.52428	-26.28678	4567	
46	1	CTD_Thermistor	End	Jul 07 2009 15:49:17	24.52418	-26.28790	4567	
47	1	Mooring recovery	released	Jul 09 2009 07:58:28	27.62167	-24.51083	5146	LOCO 13/4
47	1	Mooring recovery	Begin	Jul 09 2009 08:31:37	27.60967	-24.52703	5146	
47	1	Mooring recovery	End	Jul 09 2009 10:17:18	27.57600	-24.56633	5146	
48	1	CTD_Thermistor	Begin	Jul 09 2009 10:27:44	27.57450	-24.56783	5146	
48	1	CTD_Thermistor	Bottom	Jul 09 2009 11:56:17	27.57467	-24.56850	5146	+Water Samples
48	1	CTD_Thermistor	End	Jul 09 2009 13:30:58	27.57417	-24.56833	5146	
49	1	Mooring recovery	released	Jul 10 2009 07:48:53	28.80193	-24.08267	5140	LOCO 12/4
49	1	Mooring recovery	Begin	Jul 10 2009 08:28:11	28.80062	-24.09110	5140	
49	1	Mooring recovery	End	Jul 10 2009 10:20:15	28.82280	-24.14403	5146	
50	1	CTD_Thermistor	Begin	Jul 10 2009 10:31:16	28.82380	-24.14540	5146	+Water Samples
50	1	CTD_Thermistor	Bottom	Jul 10 2009 11:57:43	28.82378	-24.14480	5146	
50	1	CTD_Thermistor	End	Jul 10 2009 13:36:35	28.82317	-24.14567	5146	
51	1	CTD_watersamplers	CANCELED	Jul 11 2009 07:08:08	29.98110	-22.98897	5109	Test
52	1	Mooring recovery	released	Jul 11 2009 07:50:00	29.97667	-22.98543	5109	
52	1	Mooring recovery	Begin	Jul 11 2009 08:28:39	29.99883	-22.99963	5115	
52	1	Mooring recovery	End	Jul 11 2009 10:25:20	29.98338	-23.05310	5128	
53	1	CTD_Thermistor	Begin	Jul 11 2009 10:45:37	29.98453	-23.05620	5128	+watersamples
53	1	CTD_Thermistor	Bottom	Jul 11 2009 12:15:04	29.98433	-23.05667	5128	
53	1	CTD_Thermistor	End	Jul 11 2009 13:55:22	29.98372	-23.05305	5128	

Appendix D Manual for EK500 readings using Matlab (*by M. Mercier*)

HELPER to record EK500 echograms on computer through serial port, with Matlab

1) EK500 preliminary settings

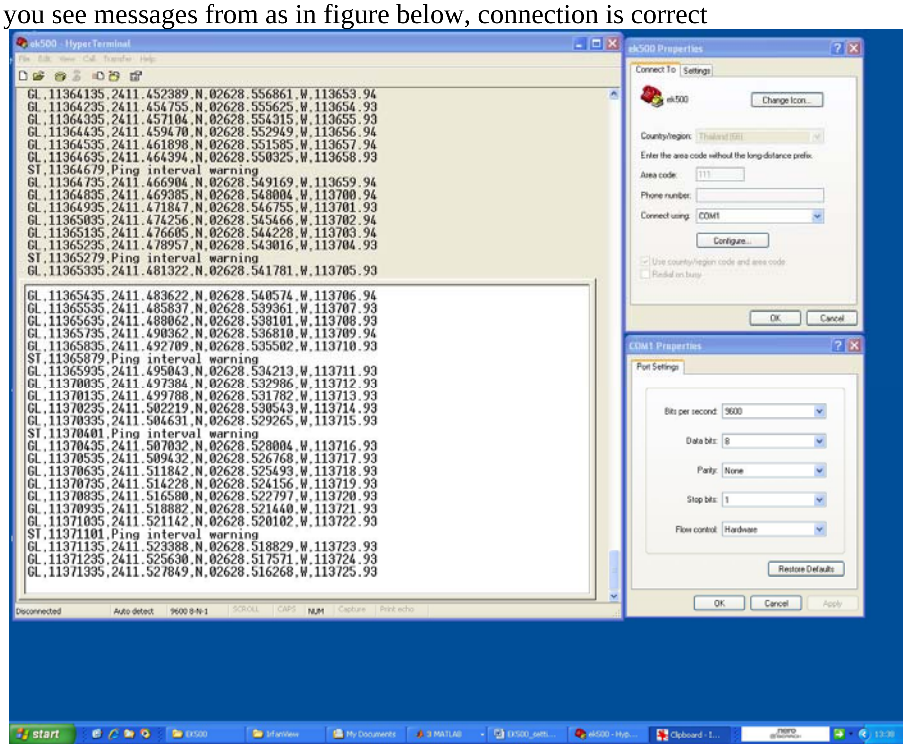
- Go to '**SERIAL COM. MENU**'
- Go to '**USART Menu**' and check setup
  - Baudrate 19200
  - Bits Per Char. 8
  - Stop Bits 1
  - Parity None
- Go back and then to '**Telegram Menu**'
- Check '**Format**' is 'ASCII' and all other items are 'OFF'
- Put '**Status**' and/or '**Navigation**' ON

Now the EK500 is sending information about its status and/or its GPS position to the serial port, you can test communication with computer.

2) Startup and connections

- connect EK500 (serial port 1) to COM port of computer using specific cable with sticker indicating **'RS232 CROSSED, Serial output of EK500 on COM1'**
- identify the serial port of your computer (use Hyperterminal in Programs/Accessories/Communications for example)
  → the number of the 'COM' port is needed (usually 1 or 2)
- check the good reception of messages from EK500 (Navigation or Status only), through Hyperterminal again or Matlab.

When you see messages from as in figure below, connection is correct



- end Hyperterminal or close Matlab serial port.

3) <u>EK500 echograms setting</u>

Setup the echogram properties using ‘**Operation Menu**’, ‘**Transceiver Menu**’ and ‘**Display Menu**’ according to your needs

→ see Simrad EK500 Operation Manual for details.

Before recording EK500 with Matlab routine “EK500_recording”, check information in ‘**SERIAL/Echogram-# Menu**’ are coherent with the setup of the ‘**Transceiver**’ and ‘**Display**’ menus, because they are independently defined.

These values are the ones recorded by Matlab’s routine

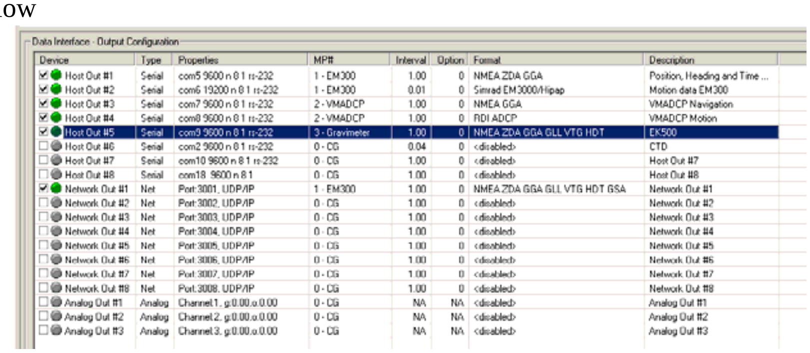
- o Range *depth range you selected for echogram*
- o Range Start *starting depth for echogram*
- o Auto Range **must be ‘Off’ during recording**
- o Bottom Range *depth range you selected for bottom echogram*
- o Bot. Range Start *starting depth for bottom echogram*
- o No. of Main Val. *Number of values taken for echogram*
- o No. of Bot. Val. *Number of values taken for bottom echogram*
- o TVG *Type of echogram (TS or Sv)*

Then, in **‘SERIAL/Telegram Menu’**, select the **‘Echogram’** you want to look at (**1**, 2, 3 or combinations 1&2, 1&3, etc).

If you want ‘**Navigation**’ information with your echograms

- Check the output format of data from Seapath to be at least of type ‘INGLL’.
- Connect EK500 (serial port 3) with Seatex Seapath 200 (serial port 9) using specific serial cable with sticker indicating **‘RS232 CROSSED, SEAPATH to EK500 serial 3’**.
- Go to ‘**NAVIGATION MENU**’ and check values
  - o Navig. Input Serial
  - o Start Sequence $INGLL
  - o Separation Char. 002C
  - o Stop Character 000A
  - o First Field No. 2
  - o No of Fields 5
  - o Speed Input Serial (or Manual)
  - o Manual Speed … (if Speed Input on Manual)
  - o NMEA Transfer On
  - o Baudrate 9600
  - o Bits Per Char. 8
  - o Stop Bits 1
  - o Parity None
- Go to ‘**SERIAL COM. MENU**’, then ‘**Telegram Menu**’ and put ‘**Navigation**’ ON

You must also check that Seapath is sending the right data through serial 9 to the EK500 as in picture below


Data Interface - Output Configuration

Device	Type	Properties	MP#	Interval	Option	Format	Description
Host Out #1	Serial	com5 9600 n 8 1 rs-232	1 - EM300	1.00	0	NMEA ZDA GGA	Position, Heading and Time ...
Host Out #2	Serial	com6 19200 n 8 1 rs-232	1 - EM300	0.01	0	Simrad EM3000/Hipap	Motion data EM300
Host Out #3	Serial	com7 9600 n 8 1 rs-232	2 - VMADCP	1.00	0	NMEA GGA	VMADCP Navigation
Host Out #4	Serial	com8 9600 n 8 1 rs-232	2 - VMADCP	1.00	0	RDI ADCP	VMADCP Motion
Host Out #5	Serial	com9 9600 n 8 1 rs-232	3 - Gravimeter	1.00	0	NMEA ZDA GGA GLL VTG HDT	EK500
Host Out #6	Serial	com2 9600 n 8 1 rs-232	0 - CG	0.04	0	<disabled>	CTD
Host Out #7	Serial	com10 9600 n 8 1 rs-232	0 - CG	1.00	0	<disabled>	Host Out #7
Host Out #8	Serial	com18 9600 n 8 1	0 - CG	1.00	0	<disabled>	Host Out #8
Network Out #1	Net	Port:3001, UDP/IP	1 - EM300	1.00	0	NMEA ZDA GGA GLL VTG HDT GSA	Network Out #1
Network Out #2	Net	Port:3002, UDP/IP	0 - CG	1.00	0	<disabled>	Network Out #2
Network Out #3	Net	Port:3003, UDP/IP	0 - CG	1.00	0	<disabled>	Network Out #3
Network Out #4	Net	Port:3004, UDP/IP	0 - CG	1.00	0	<disabled>	Network Out #4
Network Out #5	Net	Port:3005, UDP/IP	0 - CG	1.00	0	<disabled>	Network Out #5
Network Out #6	Net	Port:3006, UDP/IP	0 - CG	1.00	0	<disabled>	Network Out #6
Network Out #7	Net	Port:3007, UDP/IP	0 - CG	1.00	0	<disabled>	Network Out #7
Network Out #8	Net	Port:3008, UDP/IP	0 - CG	1.00	0	<disabled>	Network Out #8
Analog Out #1	Analog	Channel 1, g:0.00,o:0.00	0 - CG	NA	NA	<disabled>	Analog Out #1
Analog Out #2	Analog	Channel 2, g:0.00,o:0.00	0 - CG	NA	NA	<disabled>	Analog Out #2
Analog Out #3	Analog	Channel 3, g:0.00,o:0.00	0 - CG	NA	NA	<disabled>	Analog Out #3

→ to send echograms through serial port **‘Operation Menu/Ping Mode’** must be **‘Normal’**, and you must select the ‘**Ping Interval**’ (beween 0s and 20s) which corresponds to the sampling interval of your echograms

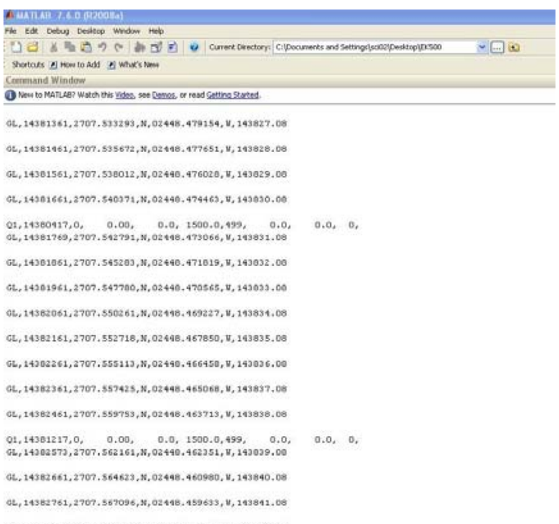
NB: A remark about size of your echos.
The maximum size of an echo seems to be 500 points (for a reason I don’t know!). So be sure you don’t take more otherwise the Range value will be meaningless (a error message is in EK500_recording to prevent this anyway).
Furthermore, if you send more than one echo, check the total number of line to be below 500 for each. Although it does not seem to be a linear issue!
→ check 5) warning no.1 for more information

4) “EK500_recording” and “EK500_display” routines

You can get these Matlab routines in L:\????????????????????? (choose directory)
Copy them on your computer (in a folder C:\EK500\ for instance) and launch Matlab.
Matlab current directory must be the one with the routines in it.
You can type in the workspace “**help thenameoftheroutine**” to read the help of the corresponding routine.

EK500_recording: to record echograms into a file by specifying the filename, the duration of recording and the ‘COM’ port identify in step 2).
Type in workspace “**EK500_recording(‘C:\EK500\data\test_recording’,100,1)**” to record for 100s, listening to COM port 1 and storing results in file test_recording.mat

EK500_display: to have a quick look at echograms recorded into a file by specifying the filename
Type in workspace “**EK500_display(‘C:\EK500\data\test_recording’)**” to look at your recording stored in C:\EK500\test_recording.mat



This is what you can see on the Matlab’s Workspace when the E*K500_recording* routine is started

5) WARNINGS

- You can record several echograms at the same time but the baudrate is limited, so be sure that no message of warning on the EK500 screen such as “Serial Com. Load warning” or “Serial Com. overload”
→ you are sending too much data through the serial port, decrease the number of main values in each echogram or the number of echograms recorded, or the ping interval.

- If Matlab routine sends an error linked to communication with the serial port such as
    - "*BaudRate could not be set to the specified value*"
    - "*Port: COM1 is not available. Available ports: COM2. Use INSTRFIND to determine if other instrument objects are connected to the requested device*"

  Check if Hyperterminal is disconnected. Start the routine again one or two times. Start Matlab again.