Report on the deployment of RAPID-WAVE moorings off Cabo Mayor and Cabo Finisterre: RAPIDO

B. O. Cornide de Saavedra
RADPROF0809 cruise 2009
Santander-Vigo, 11-22 August 2009

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Proudman Oceanographic Laboratory

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INTRODUCTION

This cruise is the first RAPID-WAVE cruise in the Gulf of Biscay and Finisterre, off the northwest coast of the Iberian Peninsula. WAVE, which stands for West Atlantic Variability Experiment, is a NERC funded project to study the variability of the Meridional Overturning Circulation in the Northwest Atlantic. Four previous RAPID-WAVE cruises have taken place in the area of the Scotian Slope/Rise in 2004, 2006, 2007 and 2008. In August 2004, 6 lander Bottom Pressure Recorder (BPR) moorings and 5 MicroCAT moorings were deployed in a line across the shelf break south of St. John's, New Foundland. This line was designated Line A (see report of RRS Charles Darwin cruise CD160). A second line, called line B, was deployed east of Halifax, Nova Scotia. Lines A and B were almost identically instrumented. Additionally, John Loder, from the Bedford Institute of Oceanography (BIO) in Dartmouth, Nova Scotia, deployed two MicroCAT/RCM near bottom moorings in line B. Recovery of these two lines in July-August 2006 was full of difficulties, with losses of 8 MicroCAT moorings and 6 lander BPRs (see report of RRS Discovery cruise D308). As a result, line A was abandoned. In line B, 4 lander BPRs and 2 MicroCAT/BPR moorings were redeployed. To try to prevent further mooring losses in the future, a joint project agreement was clinched with BIO in early 2007 to return to the Halifax line in 2007 and turn the MicroCAT/BPR moorings around, as we all as to check on some of the lander BPRs. To that effect, a cruise took place in September/October 2007. The cruise was a complete success (see report of CCGS Hudson Fall Cruise HUD07045). In September/October 2008 we carried out a second cruise on the Scotian Slope/Rise during which RAPID-WAVE line B was recovered for the last time and a new BIO/POL collaborative line made of 6 BPR/ADCP/CTD moorings was established in coincidence with the so-called Halifax line, a CTD and mooring line which is maintained by BIO as part of their contribution to the Atlantic Zone Monitoring Program (see report CCGS Hudson Fall Cruise HUD08037).

The main purpose of the new RAPID-WAVE line deployed in 2008 is to measure the bottom pressure variability across the Atlantic's western boundary (AWB). The are strong theoretical arguments to support, variations in AWB bottom pressure can be directly related to variations in the meridional overturning circulation assuming that eastern boundary pressure variability is negligible. In February 2007, a recommendation was made by the RAPID Programme Advisory Group (PAG) that this assumption should ideally be tested by deploying a line of instruments along the shelf slope on the eastern Atlantic at the same latitude of the Halifax line (see “Review and Recommendations for the RAPID MOC Observing System, February 2007”). However, no additional funding was provided for such a deployment at the time. A similar verbal recommendation was made more than one year later during the PAG meeting of October 2008. Soon after the 2008 PAG meeting, it became possible to act upon their recommendation using RAPID-WAVE funds for the period 2004-2008 that remained unspent. To this end, a memorandum of understanding was reached between the Instituto Español de Oceanografía (IEO) and POL to deploy two lander BPRs off Cabo Mayor, north of Santander, and two tube BPRs (see below) on the continental slope in the area of Finisterre, western coast of Galicia. The leaders of this research collaboration are Alicia Lavín on the part of the IEO and Miguel A. M. Maqueda for POL. A copy of the memorandum and its appendix is included at the end of this report as Appendix B (In English and Spanish).

The deployment operations were part of the IEO cruise RADPROF0809 (RADiales PROFundas 0809) that took place between the 11 and the 22 August 2009 aboard the IEO's Oceanographic Vessel Cornide de Saavedra, with Dr Guillermo Díaz del Río as Chief Scientist. A copy of the Cruise Plan is included below as Appendix C (in Spanish).

LANDER BPRs

Two RAPID landers were deployed along the RADPROF Santander line (see Figure 1). Each lander included a DigiQuartz (DQ) pressure sensor and a Novatec radio beacon (figures 2 and 3). The protocol sheets for these landers can be found in Appendix A.

SITE	LATITUDE (N)	LONGITUDE (W)	DATE & TIME DEPLOYED (Z)	DEPTH (m)	INSTRUMENT TYPE & S.N.
Mareógrafo #1	43 43.777	03 45.489	11-08-2009, 13:30/13:50	1113 (unc.)	BPR/RL14 DQ93170
Mareógrafo #2	43 45.60	03 45.50	11-08-2009, 12:37/13:01	1749 (unc.)	BPR/RL09 DQ93160

Table 1. BPR lander deployment summary. Of the two deployment times, the first is the time when the instrument was launched into the water and the second is the time when the lander hit the seabed. The instrument type entry also includes the serial number of the sensor used.

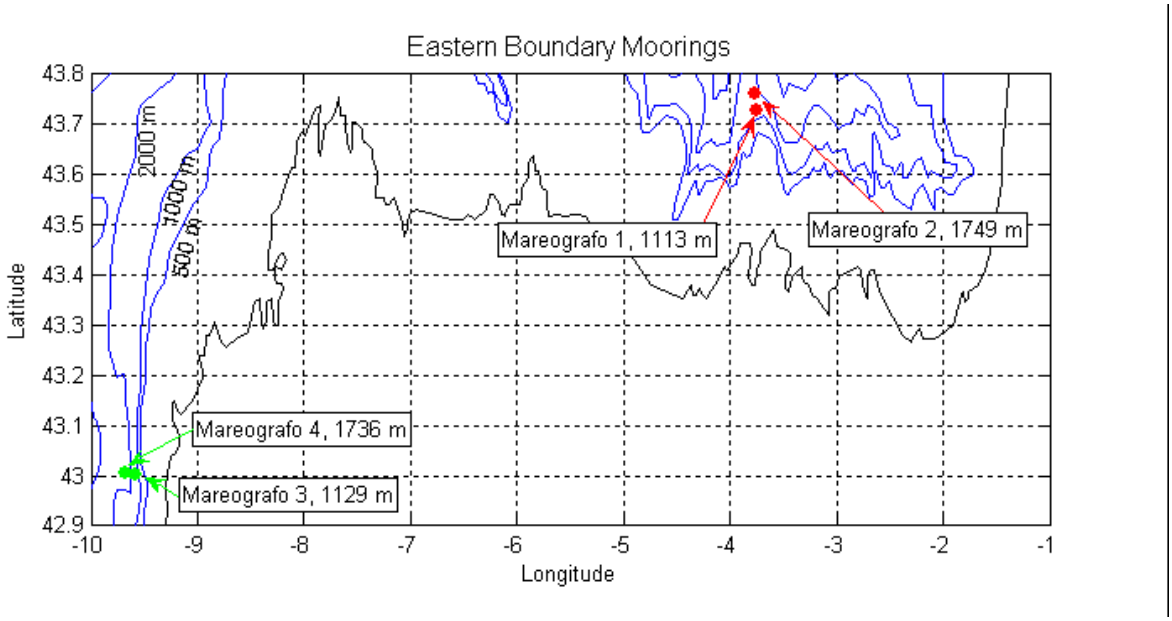


Figure 1. Locations and depths of the four BPR moorings deployed during RADPROF0809. Red: BPR deployments in the Santander line. Green: BPR deployments in the Finisterre line.

Figure 2: BPR lander "Mareografo 2" on aft deck immediately before deployment. Note the Novatec beacon on the right hand side.

Figure 3: BPR lander "Mareografo 2" during deployment deployment.

TUBE LANDER BPRs

Two long moorings were deployed along the RADPROF Finisterre line (see Figure 1). Both moorings consisted of a BPR with DQ pressure sensor sensor, a SBE 37 CT package, a Nortek current meter and a Benthos radio beacon clamped atop a float consisting of a 1.5-m long pole supported by three 10" glass spheres (Figure 4). The bases of the moorings were similar to those deployed during the cruises RRS Discovery D308 and CCGS Hudson HUD07045. They consist of a 650 kg cylindrical steel weight with a steel tripod on top. A 2-tonne rated acoustic release was clampled to the top end of the tripod. Upon deployment, the anchor weight was suspended from the release by a piece of steel chain and a cylindircal aluminium case containing a DQ sensor was clamped to one of the tripod's legs (Figure 5). For additional details, see mooring diagrams below.

The protocol sheets for these landers can be found in Appendix A.

Site	Latitude (N)	Longitude (W)	Date & time Deployed (Z)	Depth (m)	Instrument type & S.N.
Mareógrafo #3	43 00.142	09 34.577	16-08-2009, 02:28	1129 (unc.)	BPR/TRL03 DQ92918
Mareógrafo #4	43 00.237	09 40.866	16-08-2009, 03:29	1736 (unc.)	BPR/TRL02 DQ43118

Table 2: Long mooring deployment summary. Only one deployment time is given here as the moorings were not tracked during their descent to the bottom. The instrument type entry also includes the serial number of the sensor used.

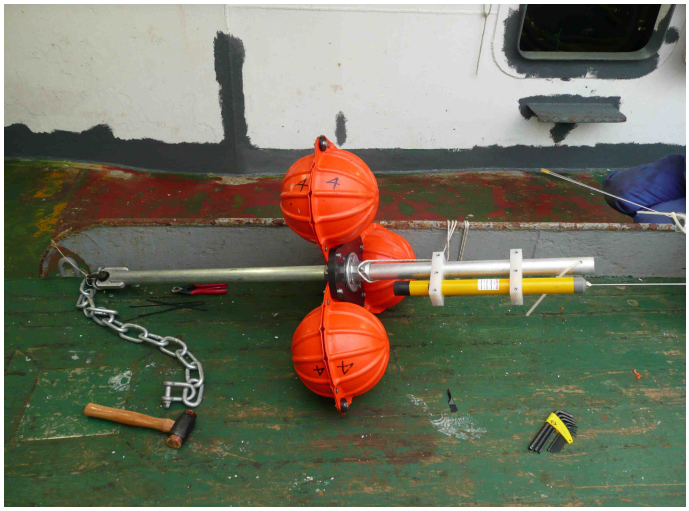


Figure 4: Recovery float with Benthos radio beacon ready for deployment. The change at the bottom end of the float will force it to remain upright at the surface during recovery.

Figure 5: Tripod base of mooring with anchor weight, aluminium case for BPR and acoustic release.

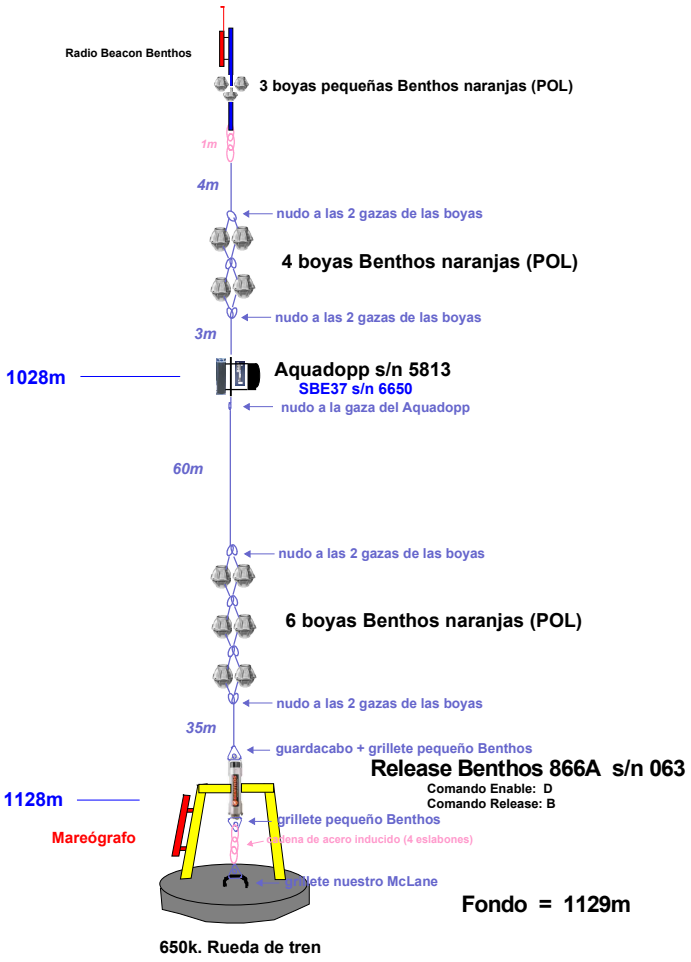
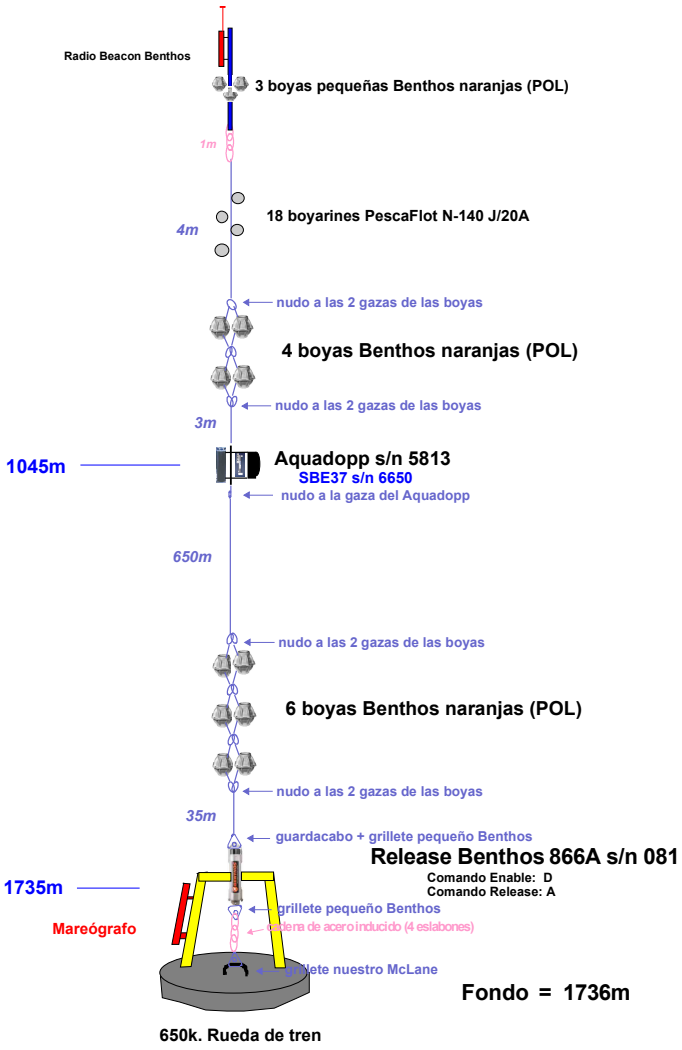


Figure 6: Schematic of mareografo 3 (courtesy of David Marcote).



Esquema del fondeo Radial Fisterra 1700m 43º 00.237' N 09º 40.866' W

De Agosto 09 a Septiembre 10

Figura 7: Schematic of mareografo 4 (courtesy of David Marcote).

APPENDIX A. DEPLOYMENT PROTOCOL SHEETS

Tide Gauge Protocol Sheet
Deployment

Deployment No		Ship/Cruise No	**Cornide de Saavedra RADPROF0809**	
Deployment date	**11-08-2009**		Mooring name	**Mareografo 1**
Timeon station	**13:30** GMT		Latitude	**43 43.777 N**
Time into water	**13:31** GMT		Longitude	**03 45.489 W**
Timeon the seabed	**13:50** GMT		Depth	**1113 (uncorrected)**

Acoustic Release Information

Type	S/N	Tx	Rx	Release code	Enable code	Release lead S/N	B/W lead S/N	BW (V)	Battery (V)	Current (mA)	BW Polarity Check
	RL/4	**12.0**	**13.5**	**C**			**TT**	**28.77**			**V**

Recovery Equipment Information

Radio Beacon Type	Radio Beacon S/N	Radio Frequency	Release Gate S/N	Flashing Light S/N
Novatec	**V01-054**	**154.585 MHz**		

Notes

Ex Oban deck unit used. Required high gain setting to communicate to the seabed – no sea noise. Slant range reading on seabed was 1189 m.

Recovery

Recovery date		Ship/Cruise No	
Time on station	GMT	Release transmitted	GMT

Time of release	GMT	Time on the surface	GMT

Notes

Configuration Information

Logger

Logger type	**RL14**	ID Number		
Sensors	**DQ 93170**			
Current (mA)		Battery (V)		
Timebase started at	**09:15:00**	GMT	Start date	**10-08-2009**
First scan at	**09:29:59**	GMT	Scan date	**10-08-2009**
Sample interval	**15**	minutes		
Last scan time		GMT	Scan date	
Expected scan time		GMT	Scan date	
Data file name				

Notes

SBE37-SMP Microcat

Serial Number			Depth rating	
DDMMYY		HHMMSS		GMT
StartDDMMYY		StartHHMMSS		GMT
NAvg		StoreTime	Y	
Interval		Seconds	StartLater	Y

Recovery - use DS command, then stop.

Date		Time	
GMT Time		SampleNum	

Data file name	

Inverted Echo Sounder

IES start date		IES start time		GMT
First CHIRP date		First CHIRP time		GMT
CHIRP interval		minutes	Lockout time	**0**
Sample rate	**Fast**	Samples per datafile		
Start file number		Deployment number		
Comment				
Last IES CHIRP		GMT	CHIRP date	
Number of datafiles		Data file name		

Tide Gauge Protocol Sheet
Deployment

Deployment No		Ship/Cruise No	**Cornide de Saavedra RADPROF0809**	
Deployment date	**11-08-2009**		Mooring name	**Mareografo 2**
Timeon station	**12:35** GMT		Latitude	**43 45.60 N**
Time into water	**12:37** GMT		Longitude	**03 45.50 W**
Timeon the seabed	**13:01** GMT		Depth	**1749 m**

Acoustic Release Information

Type	S/N	Tx	Rx	Release code	Enable code	Release lead S/N	B/W lead S/N	BW (V)	Battery (V)	Current (mA)	BW Polarity Check
		12.0	**10.5**	**B**			**TT**	**28.35**			**V**

Recovery Equipment Information

Radio Beacon Type	Radio Beacon S/N	Radio Frequency	Release Gate S/N	Flashing Light S/N
Novatec	**S01-477**	**154.585 MHz**		

Notes

Ex Oban deck unit used. Required high gain setting to communicate to the seabed – no sea noise. Slant range reading on the seabed was 1798 m.

Recovery

Recovery date		Ship/Cruise No		
Time on station		GMT	Release transmitted	GMT
Time of release		GMT	Time on the	GMT

		surface	

Notes

Configuration Information

Logger

Logger type	**RL09**	ID Number		
Sensors	**DQ 93160**			
Current (mA)		Battery (V)		
Timebase started at	**10:30:00**	GMT	Start date	**10-08-2009**
First scan at	**10:44:59**	GMT	Scan date	**10-08-2009**
Sample interval	**15**	minutes		
Last scan time		GMT	Scan date	
Expected scan time		GMT	Scan date	
Data file name				

Notes

SBE37-SMP Microcat

Serial Number			Depth rating	
DDMMYY		HHMMSS		GMT
StartDDMMYY		StartHHMMSS		GMT
NAvg		StoreTime	Y	
Interval		Seconds	StartLater	Y

Recovery - use DS command, then stop.

Date		Time	
GMT Time		SampleNum	
Data file name			

Inverted Echo Sounder

IES start date		IES start time		GMT
First CHIRP date		First CHIRP time		GMT
CHIRP interval		minutes	Lockout time	**0**
Sample rate	**Fast**	Samples per datafile		
Start file number		Deployment number		
Comment				
Last IES CHIRP		GMT	CHIRP date	
Number of datafiles		Data file name		

Tide Gauge Protocol Sheet
Deployment

Deployment No	**1**	Ship/Cruise No	**Cornide de Saavedra, RADPROF0809**	
Deployment date	**16-08-2009**		Mooring name	**Mareografo 3**
Time on station	GMT		Latitude	**43 00.142 N**
Time into water	**02:28** GMT		Longitude	**09 34.577 W**
Time on the seabed	GMT		Depth	**1129 (uncorrected)**

Acoustic Release Information

Type	S/N	Tx	Rx	Release code	Enable code	Release lead S/N	B/W lead S/N	BW (V)	Battery (V)	Current (mA)	BW Polarity Check
Benthos 866A	**063**	**12.0**	**11.0**	**B**	**D**						

Recovery Equipment Information

Radio Beacon Type	Radio Beacon S/N	Radio Frequency	Release Gate S/N	Flashing Light S/N
Benthos	**011**	**154.585 MHz**		

Notes

Recovery

Recovery date		Ship/Cruise No		
Time on station	GMT		Release transmitted	GMT
Time of release	GMT		Time on the	GMT

		surface	

Notes

Configuration Information

Logger

Logger type	**TRL03**	ID Number		
Sensors	**DQ 92918**			
Current (mA)	**1.345**	Battery (V)	**14.72**	
Timebase started at	**08:15:00**	GMT	Start date	**13-08-2009**
First scan at	**08:29:59**	GMT	Scan date	**13-08-2009**
Sample interval	**15**	minutes		
Last scan time		GMT	Scan date	
Expected scan time		GMT	Scan date	
Data file name				

Notes

SBE37-SMP Microcat

Serial Number	**6650**		Depth rating	
DDMMYY		HHMMSS		GMT
StartDDMMYY		StartHHMMSS		GMT
NAvg		StoreTime	Y	
Interval	**1800**	Seconds	StartLater	Y

Recovery - use DS command, then stop.

Date		Time	
GMT Time		SampleNum	
Data file name			

Inverted Echo Sounder

IES start date		IES start time		GMT
First CHIRP date		First CHIRP time		GMT
CHIRP interval		minutes	Lockout time	**0**
Sample rate	**Fast**	Samples per datafile		
Start file number		Deployment number		
Comment				
Last IES CHIRP		GMT	CHIRP date	
Number of datafiles		Data file name		

Tide Gauge Protocol Sheet
Deployment

Deployment No		Ship/Cruise No	**Cornide de Saavedra RADPROF0809**	
Deployment date	**16-08-2009**		Mooring name	**Mareografo 4**
Timeon station		GMT	Latitude	**43 00.237 N**
Time into water	**03:29**	GMT	Longitude	**09 40.866 W**
Timeon the seabed		GMT	Depth	**1736 (uncorrected)**

Acoustic Release Information

Type	S/N	Tx	Rx	Release code	Enable code	Release lead S/N	B/W lead S/N	BW (V)	Battery (V)	Current (mA)	BW Polarity Check
Benthos	**081**	**12.0**	**10.0**	**A**	**D**						

Recovery Equipment Information

Radio Beacon Type	Radio Beacon S/N	Radio Frequency	Release Gate S/N	Flashing Light S/N
Benthos	**041**	**154.585 MHz**		

Notes

Recovery

Recovery date		Ship/Cruise No		
Time on station		GMT	Release transmitted	GMT
Time of release		GMT	Time on the surface	GMT

Notes

Configuration Information

Logger

Logger type	**TRL02**	ID Number		
Sensors	**DQ 43118**			
Current (mA)	**1.378**	Battery (V)	**14.72**	
Timebase started at	**08:15:00**	GMT	Start date	**14-08-2009**
First scan at	**08:29:59**	GMT	Scan date	**14-08-2009**
Sample interval	**15**	minutes		
Last scan time		GMT	Scan date	
Expected scan time		GMT	Scan date	
Data file name				

Notes

SBE37-SMP Microcat

Serial Number	**6651**		Depth rating	
DDMMYY		HHMMSS		GMT
StartDDMMYY		StartHHMMSS		GMT
NAvg		StoreTime	Y	
Interval	**1800**	Seconds	StartLater	Y

Recovery - use DS command, then stop.

Date		Time	
GMT Time		SampleNum	
Data file name			

Inverted Echo Sounder

IES start date		IES start time		GMT
First CHIRP date		First CHIRP time		GMT
CHIRP interval		minutes	Lockout time	**0**
Sample rate	**Fast**	Samples per datafile		
Start file number		Deployment number		
Comment				
Last IES CHIRP		GMT	CHIRP date	
Number of datafiles		Data file name		

APPENDIX B. MEMORANDUM OF UNDERSTANDING BETWEEN THE IEO AND POL

MEMORANDUM OF UNDERSTANDING
MEMORANDO DE ENTENDIMIENTO

BETWEEN
ENTRE

THE PROUDMAN OCEANOGRAPHIC LABORATORY (POL)
EL PROUDMAN OCEANOGRAPHIC LABORATORY (POL)

AND
Y

THE INSTITUTO ESPAÑOL DE OCEANOGRAFÍA (IEO)
EL INSTITUTO ESPAÑOL DE OCEANOGRAFÍA (IEO)

15/07/2009

Terms for a memorandum of understanding between the Proudman Oceanographic Laboratory and the Instituto Español de Oceanografía for the deployment of Bottom Pressure Recorders in the north-eastern Atlantic boundary as part of the West Atlantic Variability Experiment.

Términos para un Memorando de Entendimiento entre el Proudman Oceanographic Laboratory y el Instituto Español de Oceanografía para el fondeo de Aparatos de Registro de Presión de Fondo en el borde del Noreste Atlántico como parte del experimento de Variabilidad del Atlántico Occidental.

1. Introduction
Introducción

This Memorandum of Understanding has been drafted by the Proudman Oceanographic Laboratory (POL) and the Instituto Español de Oceanografía (IEO) in support of POL's West Atlantic Variability Experiment (WAVE). This experiment is part of the meridional overturning circulation monitoring system established within the Rapid Climate Change (RAPID) Research Programme of the Natural Environment Research Council (NERC) of the United Kingdom.

Este Memorando de Entendimiento ha sido elaborado por el Proudman Oceanographic Laboratory (POL) y el Instituto Español de Oceanografía (IEO) como apoyo al Experimento de Variabilidad del Atlántico Occidental, liderado por el POL. Este experimento forma parte del sistema de monitorización de la circulación meridional de retorno establecido dentro del Programa Temático de Investigación 'Rapid Climate Change' (RAPID) del Natural Environment Research Council (NERC) del Reino Unido.

2. Working Programme
Programa de trabajo

The working programme will be as described in the document attached as Appendix A.

El programa de trabajo se describe en el documento adjunto Apéndice A.

3. Duration of the agreement
Duración del Acuerdo

The memorandum of understanding will be deemed to have started on 1st August 2009, and shall remain in force for a period of 16 months, terminating on the 30th November 2010.

El comienzo de este Memorando de Entendimiento se considerará el 1 de Agosto de 2009, y será vigente por un periodo de 16 meses, finalizando el 30 de Noviembre de 2010.

4. Variation of requirements
Modificación de requisitos

If either party wishes to vary the requirements of the memorandum of understanding outlined in Appendix A, it should not be done without the prior consent of the other party. Any significant variation should be confirmed in writing and approved by both parties.

Si alguna de las partes desea modificar los requisitos de este Memorando de Entendimiento descritos en el Apéndice A, no deberá realizarse sin previo consentimiento de la otra parte. Cualquier cambio significativo deberá ser notificado por escrito y aprobado por las dos partes.

5. Personnel
Personal

This working programme will be coordinated by Dr. Miguel Ángel Morales Maqueda (POL) and Dr. Alicia Lavín Montero (IEO) or their appointed representatives.
Should the need arise to change the appointed officers, or should circumstances prevent the appointed officers from undertaking their duties, details of the proposed new appointments should be forwarded to the directors of POL and IEO for consideration and approval.

Este programa de trabajo será coordinado por el Dr Miguel Ángel Morales Maqueda (POL) y por la Dra Alicia Lavín (IEO), o por sus respectivos representantes nominados.
En caso de que surja la necesidad de cambiar los representantes nominados, o las circunstancias les impidieran asumir sus tareas, los detalles de la propuesta de sustitución deberán ser dirigidos a los respectivos directores de los organismos POL e IEO para su consideración y aprobado.

6. Funding
Financiación

Funding for the working programme amounts to 12,000€. A table showing the breakdown of these costs is contained in Appendix A (Part I – POL, Financial Liabilities, Cash Contributions).

La financiación para el programa de trabajo es de 12 000 EUR. En el Apéndice A (Parte I – POL, Responsabilidades Financieras, Aportes Económicos) se encuentra una tabla mostrando el desglose de costes.

7. Settlement of accounts
Pago de cuentas

Within the limits of the agreed funding, one or two payments will be made by POL to IEO once the activities outlined in Appendix A have been completed to the satisfaction of both parties. A settlement claim should be submitted by IEO to POL and be accompanied by an income and cost statement. The claim will include the following text: "*I certify that the amounts claimed were designated to the sole purposes defined in the contract"* and signed by either the Head of Administrative or the Director of the IEO facilities in question.

Dentro de los límites de los fondos acordados, el POL efectuará uno o dos pagos al IEO una vez se

hayan alcanzado satisfactoriamente para las dos partes las actividades señaladas en el Apéndice A. El IEO deberá presentar al POL una solicitud de ingreso, que deberá ser acompañada por un estado de gastos. En dichas solicitudes se declarará lo siguiente: "*Yo certifico que las cantidades reclamadas han sido destinadas al objeto definido en el acuerdo de la concesión*" y firmado tanto por el Jefe de Administración como por el Director del Centro del IEO.

8. Report
Informe

A report of the activities outlined in Appendix A will be written by Dr. Morales Maqueda once these activities have been completed. The contents of such report must be approved by both parties.

Una vez finalizadas las actividades descritas en el Apéndice A, el Dr. Morales Maqueda elaborará un informe. El contenido de dicho informe deberá ser aprobado por ambas partes

9. Disputes
Conflictos

The representatives are expected to resolve any disputes which may arise. Should they be unable to do so, the issue will be referred to the directors of POL and IEO. If they cannot reach an agreement, both parties agree to abide by the fairest resolution suggested by an impartial third party, avoiding any unnecessary delays or expenses.

Es de esperar que los representantes resuelvan cualquier conflicto que pueda surgir. En caso de que no fuesen capaces de hacerlo la cuestión deberá ser remitida a los respectivos directores del POL e IEO. Si no se llegase a un acuerdo, ambas partes acordarán asumir la solución más justa al conflicto que aporte una tercera parte evitando que se produzcan demoras o gastos innecesarios.

10. Entire Memorandum of Understanding
Memorando de Entendimiento completo

The entire Memorandum of Understanding (MOU) – this MOU plus any Schedules (which are incorporated into and made a part of this MOU) - constitutes the complete MOU between the parties relating to its subject matter. Each party acknowledges that it has not entered into this MOU on the basis of any warranty, representation, statement, agreement or undertaking except those expressly set out in this MOU. Each part waives any right to non-compliance or to rescission of this MOU in regard to any matter which has not been expressly provided for in this MOU. However, this clause does not exclude liability which any party may have with respect to any other (or any right which any party may have to rescind this MOU) in regard to any false testimony or fraudulent action prior to the implementation of this MOU.

Memorando de Entendimiento completo (MDE) – este MDE y cualquier Programa (que se incorpore y forme parte de este MDE) - constituye el MDE completo entre las partes involucradas en su contenido. Cada una de las partes acepta que no se incorpora a este MDE en base a una garantía, representación, declaración, acuerdo o asunción excepto aquellas expresamente detalladas en este MDE. Cada una de las partes renuncia a cualquier derecho de incumplimiento o rescisión de este MDE respecto a cualquier representación que no esté expresamente previsto en este MDE. No

obstante, esta cláusula no exime de la responsabilidad que alguna de las partes pueda tener con cualquier otra (o cualquier derecho que alguna de las partes pueda tener para rescindir este MDE) con respecto a cualquier declaración falsa o encubrimiento fraudulento previo a la ejecución de este MDE.

11. Representation
Representantes

The Programme Leaders who will provide liaison between POL and IEO on all aspects of the work shall be:

Los Responsables del Programa que facilitarán el vínculo entre el POL y el IEO en todos los aspectos de trabajo serán:

Por el POL: For POL:

Dr. Miguel Ángel Morales Maqueda
Proudman Oceanographic Laboratory
6 Brownlow Street
Liverpool
L3 5DA
United Kingdom

Teléfono: Telephone: 0151 795 4851
Fax: 0151 795 4918
E-Mail: mamm@pol.ac.uk

Por el IEO: For the IEO:

Enrique Tortosa Martorell
Instituto Español de Oceanografía
Avenida Brasil 31
28020 MADRID
España

Teléfono: Telephone: 00 34 914175411
Fax: 00 34 915551954
E-Mail: director@md.ieo.es

Signatures
Firmas

We agree that this service level memorandum of understanding represents an acceptable specification of the working programme to be undertaken and the specified funding system.

Acordamos que este Memorando de Entendimiento a nivel de servicio representa una especificación aceptable del programa de trabajo para ser asumido y del sistema de financiación especificado.

Signatures
Firmas

For and on behalf of the Proudman Oceanographic Laboratory
Por y en representación del Proudman Oceanographic Laboratory

Firmado: Signed: Prof. Andrew J. Willmott

Cargo: Post: Director of POL
Director del POL…..……

Fecha: Date: …….

For and on behalf of the Instituto Español de Oceanografía
Por y en representación del Instituto Español de Oceanografía

Firmado: Signed: Dr. Enrique Tortosa Martorell ……..

Cargo: Post: ……General Director of IEO
Director General del IEO……

Fecha: Date: ……..

APPENDIX A (OF IEO-POL MEMORANDUM OF UNDERSTANDING)

Memorandum of understanding between POL and IEO for the deployment of hydrographic equipment on the Atlantic's eastern boundary in support of the "RAPID West Atlantic Variability Experiment (WAVE)".

Background

As a contribution to the UK Rapid Climate Change (RAPID) program, the Proudman Oceanographic Laboratory (POL) has been making moored measurements of bottom pressure and temperature-salinity on lines across the continental shelf break south of St. John's (Newfoundland), on the lower Scotian Slope/Rise (near the Bedford Institute of Oceanography's, BIO, Halifax Line), and at the Woods Hole Oceanographic Institution's Line W southeast of Cape Cod, since 2004. The project is referred to as the Western Atlantic Variability Experiment (WAVE), and has the goal of demonstrating the viability of monitoring variability in the North Atlantic's Meridional Overturning Circulation (MOC) by measuring western boundary variables only, ocean bottom pressure specially.

Adverse experience during the recovery of scientific equipment in the St. John's and Halifax lines in 2006 (see report for RRS Discovery cruise D308[1]) led POL to seek a formal collaboration with BIO for the annual recovery and redeployment of WAVE instruments. In 2007, BIO and POL entered a Joint Project Agreement for collaboration in the last two years of the RAPID WAVE program. The project, entitled "Variability in Deep Western Boundary Flows off Atlantic Canada", focuses on the Halifax line, the St. John's line having been abandoned in 2006, and has been fully successful to date.

A criticism that has been repeatedly raised in meetings of the RAPID observing system Review Group (19th-20th February 2007 and 21st October 2008) is that WAVE needs to better support their assumption that MOC variability can be successfully monitored ignoring eastern boundary processes. In particular, while this assumption is underpinned by strong theoretical arguments, it would be desirable to also gather observational evidence for it by directly measuring bottom pressure on the eastern Atlantic board. With the purpose of addressing this criticism, and encouraged by the success of the joint POL-BIO work in the northwest Atlantic, POL has sought to establish a research collaboration with the Instituto Español de Oceanografía (IEO) aiming at procuring bottom pressure data on the eastern side of the Atlantic at a latitude as close as possible to that of the Halifax instrument line on the western boundary (~43N). The IEO carries out hydrographic cruises to the Galicia Bank once per year and runs short surveys off Santander on an approximately monthly basis.

1 http://www.bodc.ac.uk/projects/uk/rapid/data_inventories/cruise/

Objectives

The objective of this project are:

1) To take measurements of bottom pressure and other hydrographic variables as temperature, salinity and currents at specified sites on the eastern Atlantic board.
2) To validate --or invalidate, as the case may be-- the hypothesis that for long enough timescales (greater than one year), variability of bottom pressure on the eastern boundary can be neglected in the calculation of the MOC.
3)
4) To study the variability of the bottom pressure at different positions an depths in the Eastern boundary of the Iberian basin and the southern Bay of Biscay.
5)

Deliverables

1. Deployments and recoveries.
    1. Four Bottom Pressure Recorder moorings, two T/S sensors and two current meters to be deployed in August 2009 at depths approximately coincident with those of moorings deployed in the POL-BIO Halifax line (namely, 1100 m, 1700 m, 2300 m, 2800 m, 3400 m and 3900 m). The optimal site for these deployments (western flank of the Galicia Bank and shelf slope north of Santander) will be agreed by POL and IEO in due time.
    2. Moorings to be recovered in September 2010. Discussions between POL and IEO will be held in 2010 ahead of the recovery cruise on the desirability and affordability of a mooring redeployment.
2. Quality controlled and processed bottom pressure data (plus temperature, salinity and density if they are also measured) to be delivered to the British Oceanographic Data Centre (BODC) and made freely available to POL and IEO.

Start/End Dates

Start: 1st August 2009
End: 30 November 2010

Reporting

1. Cruise reports will be prepared by Dr Morales Maqueda (POL), submitted to IEO for endorsement and finally archived at POL and BODC.

Work plan

Part I – POL

1. **Work Responsibilities**
    1. Lead the preparation of 4 BPRs and BPR frames, including anchors and

releases.
2. Supplement the 2 westernmost moorings with 1 T/S instrument each.
3. Freight all mooring equipment to the IEO laboratory Ship departure to be determined ahead of the 2009 cruise or directly to the ship Cornide de Saavedra.
4. Provide two engineers/scientists for the handling, deployment and recovery of the BPR moorings.
5. Carry out quality control and processing of all data collected in the project.

2. **Financial Responsibilities**
    1. In-kind contributions:
        1. Salaries and seagoing allowances (1 technician x 7 days x 2 cruises x £150): £2,100.
        2. Overtime (1 technician x (2 x 6) hours x £12.75): £153.
        3. Preparation of equipment and consumables (e.g., batteries): £5,000.
        4. Depreciation of equipment (14% of value: £50,000): £7,000.
        5. Operating expenses (e.g., T&S): £2,500.
    2. Cash contributions:
        1. Technical support, ship time and equipment maintenance during the 2009 and 2010 RADPROF0909 and RADPROG0910 cruises of the project COVACLAN on board Cornide de Saavedra or other IEO ship. 8000€
        2.
        3. Consumables and batteries. 1000€
        4. Travel and expenses for IEO personal to visit POL in order to collaborate in mooring design and data analysis. Total: 3000€

Part II – IEO

1. **Work responsibilities**
    1. Support for the deployment and recovery of the BPR moorings by providing:
        1. Vessel time.
        2. Technical/navigational assistance for the mooring operations.
        3. Add two current meters and mount the mooring line on the BPR moorings when possible in the Finisterre Section western of the Galician Bank.
    2. Participate in planning, information exchange, communications and meetings related to the project, as allowed by the project funding.
2. **Financial responsibilities**
    1. In kind contributions:
        1. Two current meters to be moored in the same line that the BPR from POL: 6000€
        2. Hydrographic conditions all over the Finisterre and Santander sections measured at the cruises developed during the mooring period. Additional information will be providing at the Santander mooring position from the IEO VACLAN/ COVACLAN project: 10000€
    2. Cash contributions:
        1. IEO will make no cash contributions to the project.

Funds to be paid to IEO by POL

Upon signing the Memorandum of understanding and receipt of one or two Invoices from IEO, POL will transfer 12000€ to IEO.

APPENDIX C. CRUISE PLAN FOR RADPROF0809

PLAN DE CAMPAÑA

RadProf 0809
B/O Cornide de Saavedra
11 al 22 de agosto 2009

Puerto de Embarque: **SANTANDER**
Puerto de Desembarque: **VIGO**

Instituto Español de Oceanografía

Jefe de Campaña: **Guillermo Díaz del Río Pérez**
Centro Costero de La Coruña

1. - INTRODUCCIÓN.

En el IEO se viene desarrollando desde finales de los 80 el programa "Radiales", que establece una serie de estaciones fijas en la plataforma costera a lo largo de la geografía española en las cuales se muestrean mensualmente un conjunto de parámetros hidrográficos y biológicos. Con el objetivo de extender el muestreo a la zona oceánica en 2003 se comenzó una serie temporal de campañas por la cual se realizan muestreos hidrográficos semestralmente en tres transectos estándar perpendiculares a la costa en Finisterre, Ortegal y Cabo Mayor (Santander) cubriendo toda la columna de agua hasta unos 5000m de profundidad. Además se mantienen dos líneas de fondeo de correntímetros en puntos estratégicos. Dicha serie de campañas se conoce como "Radiales Profundas" y ha sido en parte financia en el Plan Nacional a través de los proyectos VACLAN y COVACLAN. Igualmente se han establecido muestreos de carácter oceánico en la región Canaria y se realizaban con anterioridad en el Mediterráneo Occidental. Dichas campañas se encuadran en la estrategia de monitorización oceánica asociados a los principios del programa internacional CLIVAR, entendiendo que programas de monitorización a medio-largo plazo del océano suponen la única herramienta para poder establecer una referencia válida en el sistema oceánico a la hora de determinar la variabilidad natural y el posible efecto antropogénico sobre el propio océano.

Durante el año 2009 se continua el programa de monitorización permanente centrado en las aguas oceánicas superficiales y profundas del Atlántico adyacente a Galicia y del mar Cantábrico con la RadProf0209 realizada en febrero y la campaña RadProf0909 adelantada al mes de agosto, en la cual se hará el mantenimiento de las líneas de correntímetros.

2. - OBJETIVOS CIENTIFICOS DE LA CAMPAÑA

1. El objetivo principal de la Campaña RadProf0809 es la caracterización termohalina y biogeoquímica en las aguas oceánicas de la región Galicia-Cantábrico en tres transectos estándar perpendiculares a la costa en Finisterre, Ortegal y Cabo Mayor (Santander) cubriendo toda la columna de agua hasta unos 5000m de profundidad. Dichos transectos forma parte de la serie temporal de campañas iniciada en 2003 por la cual se realizan muestreos hidrográficos semestralmente. Además y si las condiciones lo permiten se realizará un box para medida del intercambio de flujos de calor, sal, oxígeno y nutrientes del océano a la costa en Galicia y el golfo de Vizcaya. Además de caracterizar la materia orgánica particulada y disuelta en aguas profundas del NO de España, se estimará la concentración de clorofila-a mediante calibrar el fluorómetro del CTD y se determinar la composición del zooplancton (> 200µm y < 40µm) en capas profundas en el transecto de Finisterre, principalmente sobre el Banco de Galicia.

3. - ACTIVIDADES

3.1 Muestreo Hidrológico y de biología:

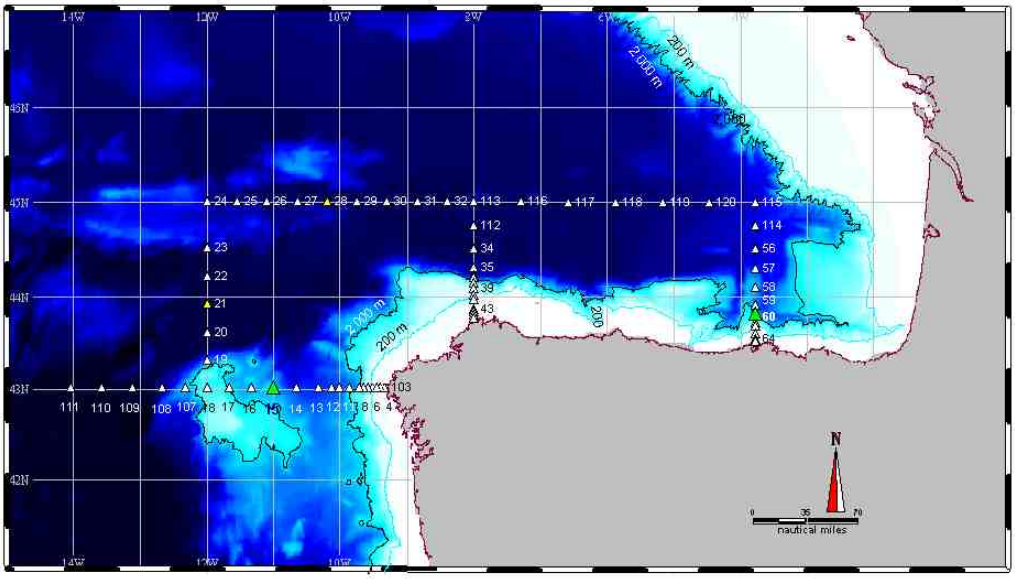
Realizando perfiles de CTD, se distribuyen las estaciones a lo largo de tres perfiles perpendiculares a la costa, que se muestrean dos veces al año, entre Finisterre y el oeste del banco de Galicia y en Cabo Ortegal y Santander (Figura 1). Además se realizarán si el tiempo lo permite dos boxes de intercambio de calor, energía, etc. El primer box se cerraría por el norte en 45ºN con 5 estaciones profundas entre las cabeceras de los radiales de Ortegal y Santander. El segundo box desde el radial de Finisterre sobre los 12ºW hasta el paralelo 45ºN y siguiendo este paralelo hasta la cabecera del radial de Ortegal.

Si el tiempo no es bueno, el cierre del segundo box se sustituirá por la realización de dos estaciones de control entre el radial de Finisterre y Ortegal y 5 estaciones entre las cabeceras de los radiales de Ortegal y Santander (Figura 2).

En cada una de las estaciones se realizará un perfil CTD/Roseta 24 botellas, si es posible con redundancia en los sensores CT y provisto a su vez de un fluorómetro. Se recogerán muestras de agua en niveles preestablecidos que se utilizarán para determinar O_2 disuelto, salinidad, nutrientes, alcalinidad, pH y en ciertos casos clorofila. Se realizarán perfiles de LADCP el cual irá también acoplado en la roseta.

Para las determinaciones de materia orgánica se recogerán aprox. 2.5 L de agua de hasta 9 profundidades de varias estaciones de los transectos de Finisterre y Ortegal, para reconstruir una sección horizontal de concentraciones de materia orgánica en cada zona.

Se tomara así mismo un volumen de 5L en total de muestras de aguas profundas puntuales del transecto de Finisterre que se fijarán con ácido fosfórico y se almacenaran de cara a su uso como patrones de referencia en los ensayos analíticos de COT.



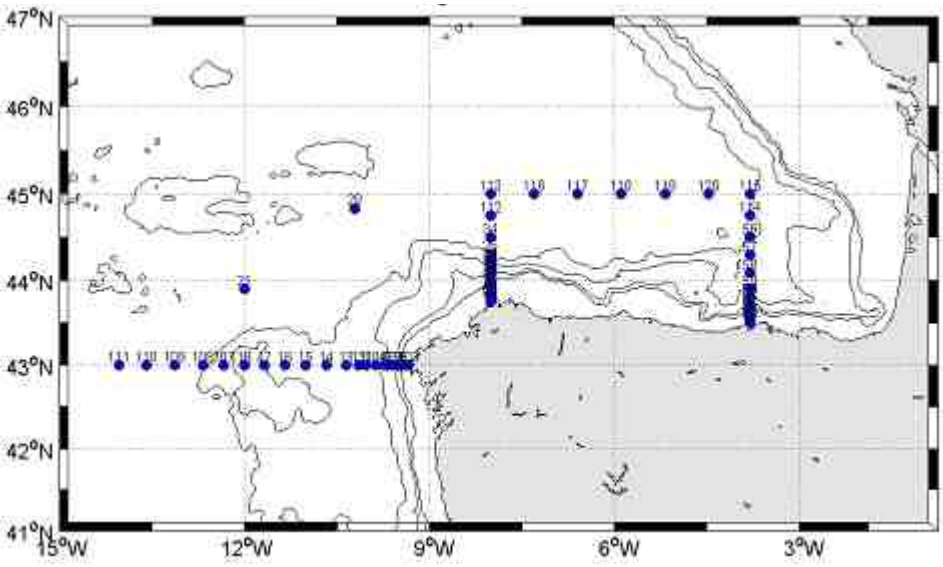


Fig. 1(a) y (b). Situación de las estaciones previstas (a), en caso de no poder cubrirse todas ellas se realizaría las presentadas en la figura 1(b) y a partir de esa reducción se irán sacrificando estaciones del extremo del Radial de Finisterre, caja 1 y las estaciones de control

Para determinar la abundancia y composición específica del zooplancton, se muestreará en 8 estaciones del transecto de Finisterre, con mayor incidencia en el Banco de Galicia. Para ello se realizarán arrastres verticales desde los 200 hasta la superficie con une red Bongo de 200µm. Las muestras recogidas se fijarán a bordo con formaldehído al 4%.

Los registros de CTD serán tratados en un primer nivel con los programas de procesado suministrados por el fabricante (Seabird) seguido de un tratamiento de post-proceso con rutinas escritas para Matlab que dejan los datos preparados para su envío al Centro de Datos a la vez que se visualizan de forma conveniente.

Para calibrado del sensor de Oxígeno montado en el CTD, en todas las estaciones se tomarán muestras de agua de las botellas de la roseta y se analizarán por el método de Winkler. El calibrado del sensor de salinidad se realizará con muestras de agua

profunda analizada a bordo con un Autosal. Se está desarrollando el software de calibrado a partir de los programas de Seabird y programas propios.

Los nutrientes se tomarán en tubos de polietileno y se congelarán a –20ºC hasta su análisis al finalizar la campaña.

Para la calibración del fluorímetro montado en el CTD se recogerán 250 ml de distintas profundidades y estaciones (aproximadamente 30 muestras) repartidas durante toda la campaña. Las muestras serán de un rango de profundidad entre 5 y 50 m y cubrirán tanto la zona costera como la oceánica

Durante toda la campaña se realizará muestreo con un termosalinómetro y un fluorómetro establecidos de forma operacional a bordo del B/A Cornide de Saavedra. Los datos del TSG se transmiten diariamente a la web del IEO y al Centro de datos internacional Coriolis. A bordo se tomarán muestras de salinidad y de clorofila para realizar el calibrado y control de calidad.

3.2. -Fondeos situados en 43ºN 11ºW y radial Santander

Se recuperaran los fondeos desplegados el pasado mes de septiembre y situados en la estación Minas (43ºN 11ºW) y en la estación 60 del radial de Santander (43º 48´N, 3º 47'W). Una vez volcada la información se hará el mantenimiento de las líneas y su posterior fondeo.

También está previsto la colocación por el personal del Proudman Oceanographic Laboratory (**POL*)* de 4 de mareógrafos (landers) en fondos de 1400 y 2000 m aproximadamente, 2 a la altura del radial de Santander y los otros 2 al oeste del Banco de Galicia en estos últimos se incluirá una línea con un correntómetro y CT a la profundidad del núcleo del AM.

4.-RELACIÓN PROVISIONAL DE PERSONAL Y TAREAS (1)

Personal	Procedencia	DNI	Función
Guillermo Díaz del Río	IEO-Coruña	32594017G	J. Campaña
Alicia Lavín	IEO-Santander	13706508A	CTD
Juan Alonso	IEO-Coruña	32588019D	CTD
Carmen Rodríguez	IEO-Santander	14926918	Química
César González-Pola (*)	IEO-Gijón	09428589S	Software&calibrado
Raquel Somavilla (**)	*IEO-Santander*		Software&calibrado
José Manuel Cabanas	IEO-Vigo	33813181F	CTD
Jesús Gago	IEO-Vigo	35457164L	Química
Ignacio Reguera	IEO-Gijón		***MCTD***- LADCP
Fernando Rozada	IEO-Coruña	71423028 R	Química
Elena Rey	IEO-Coruña	32781950G	Muestreo plancton
David Marcote	IEO-Coruña		Fondeos- LADCP
Eva Prieto Bravo	IEO-Gijón		CTD- LADCP
Ángel Merino	IEO-Santander	13898058D	CTD- LADCP
Gema Martínez	IEO-Santander		CTD-LADCP
Amaia Viloria Reparaz	IEO-Santander	72723219W	Quimica
Elena Marcos	IEO-Santander	20207121B	MADCP-LADCP
Miguel Angel Morales	POL (2)		Fondeo mareógrafos
Steve Mack	POL (2)		Fondeo mareógrafos
Otro (*)	FCM de Vigo		Fondeo
Ricardo			

(1) El manejo del torno y pórtico será realizado por tripulación del barco
(2) Proudman Oceanographic Laboratory
(*) Embarque en la Coruña , (**) desembarque en La Coruña

5.- RELACIÓN DE MATERIAL QUE SE EMBARCARÁ

La lista completa y detallada de material se presenta por laboratorios en un documento a parte:

- 3 CTDs Sbe911
- 1 Roseta Sbe 24 botellas + 24 botellas OTE 10 l.
- 1 Roseta Sbe 12 botellas + 12 botellas OTE 2.5 l.
- 1 CTD Sbe25
- 2 LADCP RDI (si se completa la reparación pendiente del esclavo)
- 1 Autosal Guidline
- 2 rampas de filtración a vacío, bombona, jeringuillas, ampollas, filtros, etc.
- 2 buretas de determinación de oxígeno, frascos, reactivos. etc.
- 2 redes Bongo, flujómetros, frascos plásticos, formol, etc.
- Repuestos generales, material de química y material informático.
- Material de fondeo, lastre, cadenas, etc.

- 2 correntómetros y 4 mareógrafos

6.- FECHAS Y ESCALAS PREVISTAS

La duración prevista es de 12 días, del 11 al 22 de agosto de la campaña, incluyendo la salida y la llegada, todos ellos dedicados a la realización de estaciones y recogida y largado de las líneas de fondeo. El puerto de salida en principio es SANTANDER y el de llegada VIGO.

Días antes de que el buque parta para Santander, se embarcará en Vigo todo el material de fondeo, se montará el sistema CTD-ROSSTA-LACDP comprobándose su correcto funcionamiento, así como el material necesario de los centros de Vigo y Coruña

Una vez finalizados los radiales de Santander y Ortegal aproximadamente el día 15, está prevista escala en La Coruña para cambio de personal

7.- DIFUSION DE RESULTADOS

Los datos obtenidos, propiedad de los participantes del proyecto, se depositarán en el banco de datos del IEO también del ICES y podrán utilizarse de acuerdo con las reglas al uso en los Centros de Datos. Durante la campaña se enviarán datos no calibrados al centro de Coriolis para uso operacional.

8.- POSICIÓN DE LAS ESTACIONES

Se presenta el listado de las estaciones de CTD.

Transecto	Estaciones	Longitud	Latitud	Profundidad
Finisterre	103	-9.3367	43	56
	3	-9.4	43	120
	4	-9.4583	43	158
	5	-9.5167	43	194
	6	-9.5833	43	1000
zoo	7	-9.65	43	1493
zoo	8	-9.7167	43	2232
	104	-9.8658	43	2290
	11	-10.0167	43	3036
zoo	12	-10.1333	43	3200
	13	-10.3333	43	3325
zoo	14	-10.6667	43	3350
Fondeo 1	15	-11	43	2477
	16	-11.3333	43	2486
zoo	17	-11.6667	43	2073
zoo	18	-12	43	1736
zoo	107	-12.3333	43	2350
zoo	108	-12.6667	43	4620
	109	-13.1225	43	5140
	110	-13.5783	43	5220
	111	-14.034	43	5242
Cierre Box NW	19	-12	43.3	2741

	20	-12	43.6	4991
Punto Control 1	21	-12	43.9	4986
	22	-12	44.2	4961
	23	-12	44.5	4884
	24	-12	45	4275
	25	-11.55	45	4058
	26	-11.1	45	4325
	27	-10.65	45	4510
Punto Control 2	28	-10.2	45	4274
	29	-9.75	45	4895
	30	-9.3	45	5027
	31	-8.85	45	4943
	32	-8.4	45	4953
Ortegal	113	-8	45	4570
	112	-8	44.75	4847
	34	-8	44.5	4850
	35	-8	44.3	4560
	36	-8	44.2167	4351
	37	-8	44.1833	3178
	38	-8	44.1333	1226
	39	-8	44.0667	256
	40	-8	44	195
	41	-8	43.95	175
	43	-8	43.85	95
	44	-8	43.8167	70
	45	-8	43.7833	55
	46	-8	43.75	61
Cierre Box NE	116	-7.2929	45	4947
	117	-6.5858	45	4963
	118	-5.8787	45	4891
	119	-5.1716	45	4757
	120	-4.4645	45	4587
Santander	115	-3.7833	45	4002
	114	-3.7833	44.75	3800
	56	-3.7833	44.5	4040
	57	-3.7833	44.2917	3250
	58	-3.7833	44.0833	2412
	59	-3.7833	43.9	2808
Fondeo 2	60	-3.7833	43.8	2330
	61	-3.7833	43.71	767
	62	-3.7833	43.6667	224
	63	-3.7833	43.5833	130
	64	-3.7833	43.525	54
	65	-3.7833	43.5	24

REPARTO DE CAMAROTES