

APPLICATION FOR CONSENT TO CONDUCT MARINE SCIENTIFIC RESEARCH
IN AREAS UNDER NATIONAL JURISDICTION OF
ICELAND

Date: 22th November 2015

1 - GENERAL INFORMATION

1.1. Cruise name and/or number: BOCATS

1.2. Sponsoring institution:

Name: CSIC, Instituto de Investigaciones Marinas

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Director: Dr. Antonio Figueras Huertas

1.3. Scientist in charge of the project:

Name: Prof. Dr. Fiz Fernández Pérez

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1.4. Scientist from Iceland involved in the planning of the project:

There is no plan for a participation from Iceland to the cruise

1.5. Submitting officer:

Name: Prof. Dr. Fiz Fernández Pérez

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2 - DESCRIPTION OF THE PROJECT

2.1. Nature and objectives of the project:

BOCATS cruise aims to evaluate the transport of water, salt, carbon and other anthropogenic biogeochemical tracers along the repeated sections A25. The section A25 has been repeated since 1997 by the National Oceanography Centre of Southampton, UK, and between 2002 and 2010 each two years by IFREMER (Laboratoire de Physique des Ocean, <http://www.ifremer.fr/lpo/ovide/>). Our group did this section in 2012, under the CATARINA project. And again, in 2014, IFREMER did de same section under the French project GEOVIDE. This repeated section is part of international programs GOSHIP (<http://www.go-ship.org/CruisePlans.html>) and CLIVAR / IOPCC (Figure 1). These programs allow the coordination between the various activities in the North Atlantic. Studies of the variability in the subpolar gyre from a hydrographic section will be integrated into the databases of CLIVAR, IOPCC and affection and has been the subject of study in the European projects CARBOOCEAN (<http://carboocean.org/>) and CARBOCHANGE (<http://carbochange.b.uib.no/>), and it is now part of the European project ATLANTOS (<https://www.atlantos-h2020.eu/home>). Another important component of BOCATS is the observation of the acidification in the North Atlantic. The North Atlantic is characterized by higher accumulation of anthropogenic CO₂ of all the oceans and this produces an increase of acidification on the water that reduces the viability of calcareous organisms.

To accomplish these goals, OVIDE and Reykjanes Ridge sections (Fig. 1) must have the necessary spatial resolution for the subsequent acquisition of a reliable velocity field. During BOCATS cruise a total of 113 hydrographic stations will be made with an average depth of 3000 meters and spaced about 30 nautical miles. CTD profiles will be obtained to the bottom and close oceanographic bottles for chemical analysis. A Lowered Acoustic Doppler Current Profiler (LADCP) will be used during the CTD casts. These measures are essential to close the inverse model to calculate geostrophic velocities throughout the water column. At each station there will be a hydrographic CTD profile with duplicate sensors temperature and salinity, dissolved oxygen additional sensors, fluorescence and turbidity. The 28 Niskin bottles will be closed during the ascension to take samples for the analysis of chlorofluorocarbons (CFC), dinitrogen oxide, dissolved oxygen, dissolved organic carbon, alkalinity, pH, nutrients, salinity and plankton composition. Once finished this maneuver, the Multicorer/Boxcorer will be launched by the stern of the starboard of the vessel and once on board they shall be sampled. Only one multi-corer/box-corer is previewed every 3-4 CTD stations.

2.2. Relevant previous or future research cruises:

In the framework of this project, the section A25 (FOUREX) has been running since 1997 with Spanish participation. This cruise was led by Dr. Sheldon Bacon from the NOCS, Southampton (http://cdiac.ornl.gov/oceans/woce_a25.html). Seven identical cruises were already occupied in 2002, 2004, 2006, 2008 and 2010 also with Spanish participation in the frame of the French project OVIDE, led by Dr. Herlé Mercier from LPO/IFREMER, France (<http://www.ifremer.fr/lpo/ovide/>). Also recent cruises on board of French RV “Pourquoi Pas?” have repeated the same section in 2014. Previously, the same section was done in 2012 on board of the Spanish RV “Sarmiento de Gamboa”. These cruises were also included in the European project CARBOCHANGE.

As part as the above mentioned collaborations, the following cruises have been carried out in the area:

• **1997 / FOUREX cruise**

PI: Sheldon Bacon (National Oceanography Centre of Southampton, UK)

Study Area: North Atlantic

Objectives: Study of the decadal variability in the North Atlantic from the eastern boundary regime via the junction of subtropical and subpolar gyres to the western boundary regime.

Equipment: CTD-rosette, ADCP

Vessel: RRS Discovery Cruise 230 (U.K.)

Dates: 7 August to 17 September 1997.

• **2002 / OVIDE 2002 cruise**

PI: Herlé Mercier (Laboratoire de Physique des Océans/IFREMER)

Study Area: North Atlantic

Objectives: Understanding the variability of the circulation and water mass properties in the northern North Atlantic within the context of global change.

Equipment: CTD-rosette, LADCP, ADCP, ARGO floats, XBT

Vessel: RV Thalassa (France)

Dates: 11 June to 11 July 2002

• **2004 / OVIDE 2004 cruise**

PI: Thierry Huck (Laboratoire de Physique des Océans /IFREMER)

Study Area: North Atlantic

Objectives: Understanding the variability of the circulation and water mass properties in the northern North Atlantic within the context of global change.

Equipment: CTD-rosette, LADCP, ADCP, ARGO floats, XBT

Vessel: RV Thalassa (France)

Dates: 4 June to 6 July 2004

• **2006 / OVIDE 2006 cruise**

PI: Pascale Lherminier (Laboratoire de Physique des Océans /IFREMER)

Study Area: North Atlantic

Objectives: Understanding the variability of the circulation and water mass properties in the northern North Atlantic within the context of global change.

Equipment: CTD-rosette, LADCP, ADCP, ARGO floats, XBT

Vessel: RV Maria S. Merian (Germany)

Dates: 16 de Junio-02 de Julio 2006

• **2008 / OVIDE 2008 cruise**

PI: Bruno Ferron (Laboratoire de Physique des Océans /IFREMER)

Study Area: North Atlantic

Objectives: Understanding the variability of the circulation and water mass properties in the northern North Atlantic within the context of global change.

Equipment: CTD-rosette, LADCP, ADCP, ARGO floats, VMP, XBT

Vessel: RV Thalassa (France)

Dates: 9 de Junio al 11 de Julio 2008

• **2009 / CAIBOX cruise**

PI: Miguel Gil Coto (CSIC, Instituto de Investigaciones Marinas)

Study Area: Eastern North Atlantic

Objectives: Estudio de la Circulación del Margen Oriental Entre la Península Ibérica y las Islas Canarias

Equipment: CTD-rosette, LADCP, ADCP,

Vessel: RV Sarmiento de Gamboa (Spain)

Dates: 25 de Julio al 14 de Agosto 2009.

• **2010 / OVIDE 2010 cruise**

PI: Virginie Thierry (Laboratoire de Physique des Océans /IFREMER)

Study Area: North Atlantic

Objectives: Understanding the variability of the circulation and water mass properties in the northern North Atlantic within the context of global change.

Equipment: CTD-rosette, LADCP, ADCP, ARGO floats, VMP, XBT

Vessel: RV Thalassa (France)

Dates: 7 de Junio al 8 de Julio 2010

• **2012 / CATARINA cruise**

PI: Aida Fernandez Rios (Instituto Investigaciones Marinas CSIC)

Study Area: North Atlantic

Objectives: Understanding the variability of the circulation and water mass properties in the northern North Atlantic within the context of global change.

Equipment: CTD-rosette, LADCP, ADCP, ARGO floats, VMP, XBT

Vessel: RV Sarmiento de Gamboa (España)

Dates: 23 de Junio al 12 de Julio 2012

• **2014 / GEOVIDE cruise**

PI: Pascale Lherminier/Geraldine Sarthou (Laboratoire de Physique des Océans /IFREMER)

Study Area: North Atlantic

Objectives: Understanding the variability of the circulation and trace elements and isotopes in the northern North Atlantic within the context of global change.

Equipment: CTD-rosette, LADCP, ADCP, ARGO floats, XBT

Vessel: RV Pourquoi Pas? (France)

Dates: 16 de Mayo al 30 de Junio 2014

2.3. Previously published research date relating to the project:

The asterisk character «*» indicates a publication directly related to the project.

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- *Diz, P; Mena, A; Nombela, MA; Castano-Carrera, M; Velo, A; Ordonez, N; Fontes-Lema, A; Frances, G; Roson, G; Perez, FF; Rios, AF. 2015 Description of an experimental set up for the culture of benthic foraminifera in controlled pH conditions. *Thalassas*. 31 - 1, pp. 23 - 32. Elsevier.
- Duarte, C.M., Alonso, S., Benito, G., Dachs, J., Montes, C., Pardo, M., Ríos, A.F., Simó, R., Valladares, F. 2006. *Cambio Global. Impacto de la actividad humana sobre el sistema tierra*. Colección Divulgación (ISBN: 978-84-00-08452-3). Editorial Consejo Superior de Investigaciones Científicas, Volumen 1: 1-166.
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PhD thesis:

- *M. Alvarez, thesis from the Universidad de Vigo, Facultad de Ciencias del Mar, prepared in CSIC, Instituto de Investigaciones Marinas (supervisors A.F. Rios, G. Rosón), sustained in February 2002

Water masses and transports of physical and chemical properties in the Subpolar North Atlantic Gyre. European Doctorate

- * G. Forget, thesis from the Université de Bretagne Occidentale, prepared in laboratoire de physique des océans (supervisors B. Ferron, H. Mercier), sustained in January 2005 : Profils ARGO et assimilation 4Dvar pour le suivi climatique de l'océan Nord Atlantique.
 - * S. Forner, thesis from the Université de Bretagne Occidentale, prepared in laboratoire de chimie marine (supervisor P. Morin), sustained in May 2005: Utilisation des CFC et du CCL4 dans l'étude de la circulation profonde de l'Atlantique Nord.
 - * C. Gourcuff, thesis from the Université de Bretagne Occidentale, prepared in laboratoire de physique des océans (supervisors P. Lherminier, H. Mercier), sustained in Octobre 2008. Etude de la variabilité de la circulation du gyre subpolaire de l'Atlantique Nord à partir des données Ovide et de mesures satellitaires.
 - * E. Louarn, thesis from the Université de Bretagne Occidentale, prepared in laboratoire de chimie marine (supervisor P. Morin), sustained in Octobre 2008. La variabilité de la circulation profonde en Atlantique Nord en relation avec le climat : Utilisation de traceurs transitoires halocarbonés. European Doctorate
- X.A. Padín, thesis from the Universidad de Vigo, Facultad de Ciencias del Mar, prepared in the CSIC, Instituto de Investigaciones Marinas (supervisors A.F. Rios, F.F. Pérez), sustained in July 2009. Evolución estacional e interanual do CO₂ no Atlántico Norte. Extraordinary Doctorate Award.
- *M. Vázquez-Rodríguez, thesis from the Universidad de Vigo, Facultad de Ciencias del Mar, prepared in the CSIC, Instituto de Investigaciones Marinas (supervisors F.F. Pérez, A.F. Rios), sustained in Novembre 2009. On the Anthropogenic CO₂ in the Atlantic Ocean: Methodological upgrade and spatiotemporal variability. Extraordinary Doctorate Award
- Noelia Maria Fajar González, thesis from the Universidade de Santiago de Compostela, Facultad de Química, prepared in the CSIC, Instituto de Investigaciones Marinas (supervisors F.F. Pérez, A.F. Rios), March 2013. Temporal changes in natural and anthropogenic CO₂ in the North Atlantic Ocean.
- Paula Conde Pardo, thesis from the Universidad de Vigo, Facultad de Ciencias del Mar, prepared in the CSIC, Instituto de Investigaciones Marinas (supervisors F.F. Pérez, A.F. Rios), sustained in June 2013. El CO₂ antrópico en el Océano Austral.
- *Lidia Carracedo Segade, thesis from the Universidad de Vigo, Facultad de Ciencias del Mar, prepared in the CSIC, Instituto de Investigaciones Marinas (supervisors F.F. Pérez, Miguel Gilcoto), sustained in July 2013. Subtropical North-East Atlantic water masses and transports
- Raquel González Álvarez, thesis from the Universidad de Vigo, Facultad de Ciencias del Mar, prepared in the Departamento de Geociencias Marinas y O.T. (supervisor. Guillermo Francés). Sustained in December 2013. Holocene climate changes and paleoceanography of the Galician continental Shelf.
- *Antón Velo Lanchas, thesis from the Universidad de Vigo, Facultad de Ciencias del Mar, prepared in the CSIC, Instituto de Investigaciones Marinas (supervisors F.F. Pérez, M. Gilcoto), sustained in Novembre 2014. Optimización de métodos numéricos en la determinación de la acidificación en los océanos.
- Anxo Mena; Guillermo Francés. thesis from the Universidad de Vigo, Facultad de Ciencias del Mar, prepared in the Departamento de Geociencias Marinas y O.T. (supervisor. Guillermo Francés). Sustained in January 2014. Paleoceanography and paleoclimatic evolution of the Galicia Interior Basin (NW Iberian Peninsula) during the past 60 ka.

Alba Marina Cobo-Viveros, thesis from the Universidad de Vigo, Facultad Ciencias del Mar, prepared in the CSIC, Instituto de Investigaciones Marinas (supervisors X.A.Padin, A.F. Rios), sustained in February 2015. CO₂ flux variability in the Galician and Californian upwelling systems.

* Maribel García Ibáñez, thesis from the Universidad de Vigo, Facultad de Ciencias del Mar, prepared in the CSIC, Instituto de Investigaciones Marinas (supervisor F.F. Pérez), sustained in July 2015. Acidification and transports of water masses and CO₂ in the North Atlantic.

3 - METHODS AND MEANS TO BE USED

3.1. Particular of vessel:

Name: SARMIENTO DE GAMBOA
Nationality: Spanish
Owner: CSIC
Operator: CSIC, UTM
Type of vessel: **Oceanographic Research Vessel**
Year built and country: **2007 by CNP Freire, Spain**
Length / width **70,5 m**
Length p.p.: **62,0 m**
Design Draught: **4,60 m**
Scantling Draught: **4,90 m**
Depth to main deck: **5,00 m**
Tonnage: Gross = **2630 GT**
Dead weight: **850 tpm**
Maximum Speed: **14,5 knots**
Prop. Power: **2400 kW**
Fuel: **528 m³**
Endurance: **40 days**
Accommodation (crew + research) **16+26**
Classification society: **Bureau Veritas, +HULL Special Service Oceanographic and Fishing Research/Unrestricted Navigation/+MACH+AUT-UMS, AUT-CCS, ALM SDS COMF-1, SYS-NEQ 1 DYNAPOS AM/AT**
Register port: **Vigo**
Call code: **E A K F**
Phone:
INMARSAT: +870.761.143.975 / INMARSAT: +870.761.143.979
VSAT:+34.931.845.898
Cellular: +34.679.510.317
Email: capitan@sdgamboa.cmima.csic.es

Name of master :

Rafael García Giráldez 36098509D

David Domínguez Añino 31247505G

Number of crew: 16



Number of scientists on board: 26

3.2. Aircraft or other craft to be used in the project:

None

3.3. Particulars of methods and scientific instruments:

Types of samples and data	Methods to be used	Instruments to be used
Hydrographic stations: measurements of temperature, salinity, dissolved oxygen, and current velocity between the ocean surface and the ocean floor. Water sampling.	The ship being in station, a cast is carried out using a rosette attached to the ship by a wire cable.	The rosette is equipped with 28 sampling bottles, a SeaBird CTDO2 (Conductivity Depth Temperature Oxygen), 2 ADCPs (Acoustic Doppler Current Profiler).
Salinity data from water samples.	Measurement of water sample conductivity.	Salinometer.
Dissolved oxygen data from water samples.	Titration of water samples using the Winkler method.	Metrohm.
Alkalinity data from water samples	Titration of water samples.	Metrohm
pH data from water samples	Analysis of water samples.	Spectrophotometer
Nitrite, nitrate, phosphate, silicate data from water samples	Analysis of water samples.	Alliance and Skalar equipments
CFCs data from water samples	Analysis of water samples	Chromatography
Underway measurement of surface temperature and surface salinity and pCO ₂ .		Seabird SBE21 Thermosalinograph General Oceanics pCO ₂ system
Continuous measurement of current velocity and direction in the surface layer.		Vessel-Mounted Acoustic Doppler Current Profiler RDI at 75 KHz and 150 KHz.
Meteorological buoys "SVP-B" and "SVP-S"	A total 10 buoys will be deployed	Meteorological buoys "SVP-B" and "SVP-S"
Surface sediments: grain-size, TOC, TIC, 210Pb	The first 30-40 cm of sediments will be retrieved by means of a multicorer or boxcorer sampler	Multicorer/Boxcorer

3.4. Indicates whether harmful substances will be used:

No

3.5. Indicate whether drilling will be carried out:

No

3.6. Indicate whether explosives will be used:

No

4 - INSTALLATIONS AND EQUIPMENTS

Details of installations and equipments (dates of laying, servicing, recovery, exact locations and depth):

Does not apply

5 - GEOGRAPHICAL AREAS

5.1. Indicate geographical areas in which the project is to be conducted (with reference in latitude and longitude):

The hydrographic line is presented in figure 1. The nominal locations of the hydrographic stations that will be occupied are indicated. Note that the locations of the stations and their number may change depending on the sea state and the characteristics of the ocean circulation at the time of the cruise.

The hydrographic stations realized within 200 Nautical Miles of Iceland will be carried out between 57°40'N and 61°N of latitude (see Figure 2).

5.2. Attach chart(s) at an appropriate scale showing the geographical areas of the intended work and, as far as practicable, the positions of intended stations, the tracks of survey lines, and the locations of specific equipments or facilities:

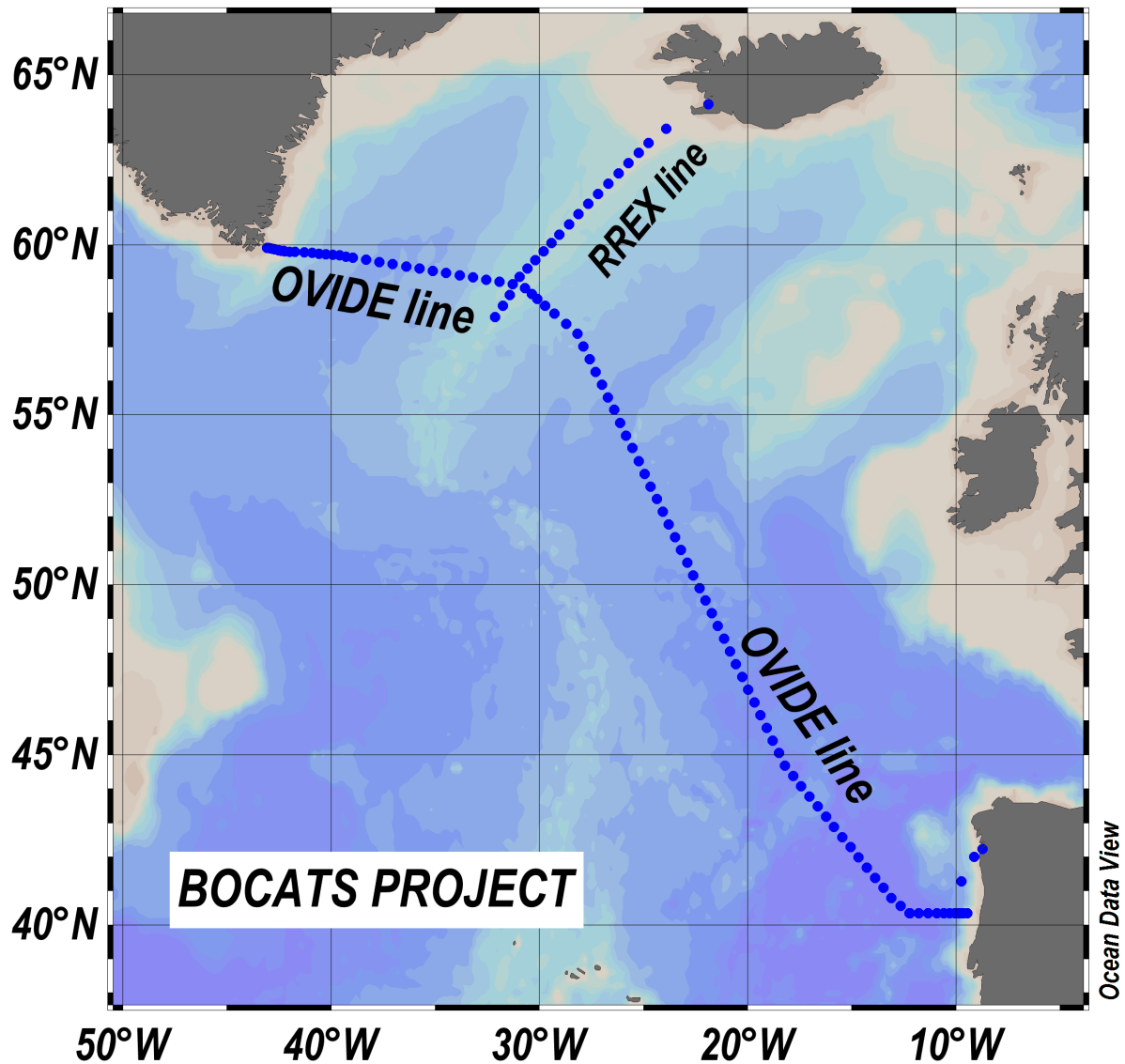


Figure 1: BOCATS cruise: Vigo→ Portugal→ Greenland→ Reykjavik. The cruise has 2 legs: OVIDE line section and RREX line. Both legs include a total of 113 hydrography/currents/sedimentology stations (blue dots) will be made during 43 days. The exact locations of the stations may vary depending on the characteristics of the ocean circulation and the sea state at the time of the cruise. The locations of the hydrographic stations scheduled within 200 Nautical Miles of the Iceland coasts can be better visualized from Figure 2.

** The study area corresponds to Spanish, Portuguese, Danish and Iceland waters. A permit to survey in Portugal and Iceland waters has also been requested.*

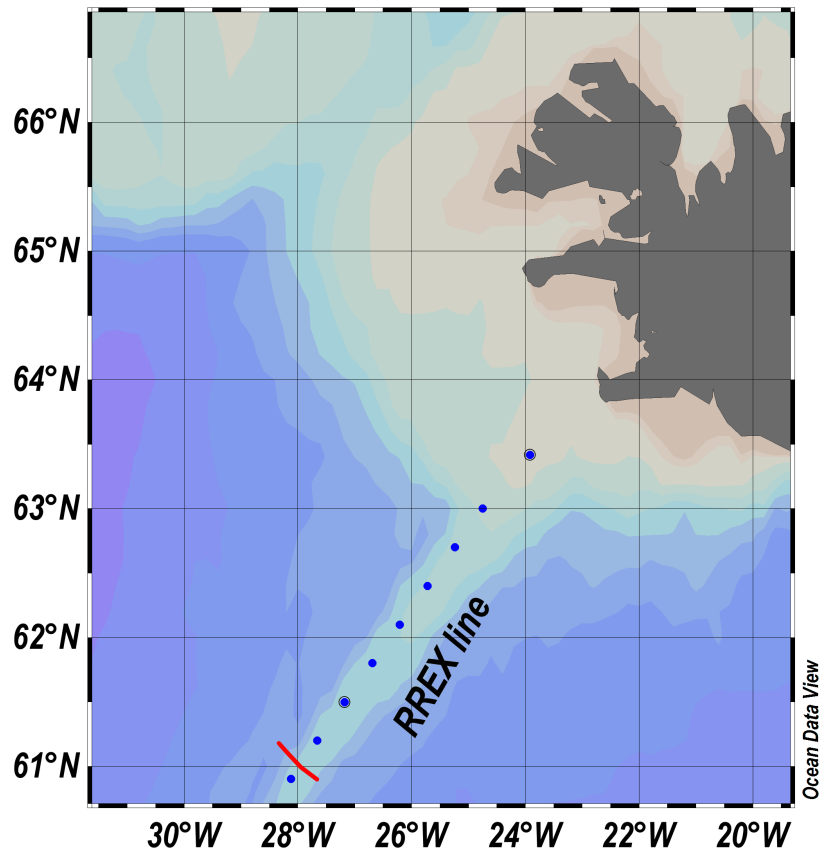


Figure 2: Locations of the hydrographic stations scheduled off Iceland during the BOCATS cruise. The exact locations of the stations may vary depending on the characteristics of the ocean circulation and the sea state at the time of the cruise. The work within 200 Nautical Miles from Iceland will be limited to the 61°N and 63.5° N latitude ranges (eight stations approx.).

6 - DATES

6.1 Expected dates of first entry into and final departure from the research area of the research vessel:

entry date : July, 5th 2016

departure date : July, 13th 2016

6.2 Indicate if multiple entry is expected:

No

7 - PORTS CALLS

7.1. Dates and names of intended ports of call in Iceland:

July, 13th 2016 Reikjavick

7.2. Any special logistical requirements at ports of call:

7.3. Name/Address/Telephone of shipping agent (if available):

8 - PARTICIPATION

8.1. Extent of which Iceland will be enabled to participate or to be represented in the research project:

There is not plan for participation of Iceland in the project. Furthermore, the cruise takes place mostly in international waters with fewer working days in the area.

We have a research contact involved in the European Project CARBOCHANGE:

Dr. Jon Olafsson

Oceanographer

Marine Research Institute of Iceland

Skulagata 4, IS 121

Reykjavik, ICELAND

Tel.

Fax.

E-mail : jon@hafro.is

8.2. Proposed dates and ports for embarkation/disembarkation:

start date : June, 1th 2016 Vigo, Spain
end date : July, 13th 2016 Reykjavik, Iceland

9 - ACCESS TO DATA, SAMPLES AND RESEARCH RESULTS

9.1. Expected dates of submission to Iceland of preliminary reports which should include the expected dates of submission of the final results:

A preliminary cruise report will be sent to Iceland authorities within three months of the end of the cruise.

9.2. Proposed means for access by Iceland to data and samples:

- Preliminary data (ASCII files) will be distributed to Iceland scientists and authorities on request using either FTP or CDROMs.
- Near real-time CTD data will be sent to the Coriolis data center
- Final data will be publicly available from the CCHDO, CDIAC data center (<http://cdiac.ornl.gov/oceans/index.html>).

9.3. Proposed means of making research internationally available:

- Oral or Poster presentations in international conferences (European sciences Union conferences, international Programs CLIVAR and GO-SHIP, European Project ATLANTOS meetings...).
- Articles in international journals in oceanography.

ANNEX

List of the scientific team

1	Fiz Fernández Pérez (ESP)
2	Pascale Lherminier (FR)
3	Guillermo Francés Pedraz (ESP)
4	Miguel Angel Nombela Castaño (ESP)
5	Irene Alejo Flores (ESP)
6	Mercedes de la Paz Arándiga (ESP)
7	Fernando Alonso Pérez (ESP)
8	Xosé Antonio Padín Alvarez (ESP)
9	María Isabel García Ibáñez (ESP)
10	Elisa Fernández Guallart (ESP)
11	Marcos Morente Fontela (ESP)
12	1 Technician of Instituto Investigaciones Marinas (ESP)
13	1 Technician of Instituto Investigaciones Marinas (ESP)
14	Patricia Zunino (ESP/FR)
15	Stéphane Leizour (FR)
16	Pierre Branelléc (FR)
17	Michel Hamon (FR)
18	Philippe Le Bot (FR)
19	Catherine LAGADEC (FR)
20	1 Students University of Bremen (GER)
21	1 Technicians CTD, UTM (ESP)
22	1 Technicians CTD, UTM (ESP)
23	1 Technicians CTD, UTM (ESP)
24	1 Technicians CTD, UTM (ESP)
25	Technician Chemical support, UTM (ESP)
26	Technician UTM Informatics (ESP)

The list will be updated 2 months prior the cruise.