CRUISE REPORT

MD166 BONUS-GOODHOPE

Geochemistry and biogeochemistry

Marie BOYE *(LEMAR, IUEM-Brest)*

R.V. Marion-Dufresne II
08/02/07 (Capetown, SA) - 08/03/24 (Durban, SA)
17°13' E 33°58' S - 00°03' W 57°33' S

CONTENT

Annexes

On board SUMMARY

In the framework of the International Polar Year (2008-2009), BONUS-GOODHOPE aims at understanding the interactions between the oceanic dynamics, the geochemistry, the biogeochemistry and the atmosphere in the Southern Ocean and south-eastern Atlantic Ocean The scientific objectives of BONUS-GOODHOPE project, coordinated by M. Boye (LEMAR, FR) and S. Speich (LPO, FR) have been endorsed by the three IPY-clusters : IPY-GEOTRACES (ID#269), IPY-ICED (ID#417), IPY-CASO (ID#132). The multidisciplinary MD166 BONUS-GOODHOPE cruise was conducted on board of the French research vessel *Marion-Dufresne II* within the study area of 33°58' S 17°14' E towards 57°33' S 00°02' W, between Feb., 13, 2008 and March, 17, 2008. This international cruise brings 60 scientists, 1 scientist for making the LOG-BOOK of the cruise and 1 student in scientific journalism, affiliated to several institutes, universities and laboratories in France, Europe, South Africa and Russia.

The cruise was conducted in synopticity and close scientific collaboration with the colleagues on board of the German research vessel Polarstern (ANT-XXIV/3 cruise) along the greenwich meridian to acquire a complete section of several parameters from the sub-tropical region towards the Antarctic Peninsula in the atlantic sector of the Southern Ocean ; and to achieve intercomparison excercices in the framework of the recently inaugurated international GEOTRACES programme.

BONUS-GOODHOPE main goals are :

1° Large scale monitoring and quantification of surface, mode and intermediate waters mass transport and ventilation in the southern hemisphere south of South Africa. Particular emphasis will be given to AAIW, SAMW and to the water properties of Agulhas rings and Cape Basin mesoscale structures.

2° Determination of the distributions of selected trace elements and isotopes (TEIs), evaluation of the sources and sinks of selected TEIs, and characterisation of the biogeochemical processes involved in the internal cycling of TEIs and the carbon cycle in the study area.

To fulfil these objectives, our general scientific approach has been based on the coupling of i) the physical oceanography ; with ii) the biogeochemistry, including nutritive trace metals (Fe, Co, Zn, Cu, Cd…), in the water-column, the atmosphere and the sediments and using on-deck incubations ; iii) the study of selected trace elements and isotopes, in the water-column and the sediments, that are tracers of lithogenic sources, of circulation, « ageing » and ventilation of water-masses, of biogeochemical processes, and that can be used to quantify the particulate export fluxes from the surface towards the deep waters ; iv) the atmospheric dynamics; and iv) with the later development of modelling that combine large and regional scales, idealized modelling, biogeochemical modelling, and simulations of trace elements and isotopes.

Dealing with the logistic and equipment "aleas" encountered at the beginning of the cruise, the field work started for physics with a XBT deployment on the 08/02/13 at 33.58°S 18.07°E, followed by tests on the CTD and the first Niskin-frame/CTD samples from the 08/02/13 at 33.58°S 17.13°E until the 08/02/17 at 34.16 °S 14.29°E. Once back from Capetown where we picked up the Kevlar-line during that time, the whole sampling work started at the first "large-type" station for the geochemists and biogeochemists on the 08/02/17 at 34.25°S 14.24 °E. The sampling strategy was then adapted with the remaining shipping time. The three stations-type (HYDRO, LARGE, SUPER) were kept as almost initially defined, but the total number of the stations were cut off. By the end and after having a very good weather along the cruise track where a delay of only 20 h was recorded due to a storm, 67 HYDRO stations instead of 70 were achieved, 7 LARGE stations instead of 20, 5 SUPER stations instead of 6, and 1 GEOTRACES intercalibration station as expected. The operations scheduled on the continental margin of the Agulhas Bank to achieve understanding the margin-open ocean exchanges fluxes (1 GO-FLO cast, 1 Niskin cast, 2 In Situ Pumps casts, 1 sediment multicorer deployment) were cancelled on the way from Capetown, as well as on the way to Durban.

Despite such cut off, the science that was achieved on board was very intense and features of promising issues. A lot of operations were conducted to collect samples and data in seawater (Niskin-CTD frame; GO-FLO casts, In Situ pumps casts, inlet surface seawater pumping, XBTs, PROVOR, CPIES, incubations), in the atmosphere (balloons, dust and rain collection, sensors), and in the sediment (surficial multicorer). Many samples were directly analysed on board, such as salinity, oxygen, nutrients, chlorophyll-a, thorium activities, dissolved iron, pCO2…; while many other collected samples were stored for later analyses back to the several international laboratories involved in the project.

The final scientific meeting held on 08/03/21-22 already showed very promising results. Further calibrations of the data recorded on board, as well as new analyses in respective homelab will bring everybody to a first scientific synthesis meeting within the next 6 months.

All together the BONUS GOODHOPE cruise was scientifically unique, since the scientists on board are issued from many different fields of oceanography and atmospheric studies, hence with a truly multidisciplinary and complementary approach of understanding the functioning of the Southern Ocean. It is also unique since it will be the first time that so many geochemical trace elements and isotopes will be recorded during a cruise, with the potential to provide unique insights into a wide range of oceanic processes.

Finally we would like to warmly acknowledge the Captain P. Courtes, all the officers and all the crew members for their wonderful work, hence making possible to bring us to this promising scientific success.

Marie Boye – *Marion Dufresne II* – March, 24, 2008.

CRUISE PARTICIPANTS

Picture 1- The BONUS-GOODHOPE cruise team

The international MD166 BONUS-GOODHOPE cruise brings 60 scientists, 1 scientist for making the CDT LOG-BOOK of the cruise and 1 student in scientific journalism, all affiliated to several institutes, universities and laboratories in France, Europe, South Africa and Russia. The names of the BONUS-GOODHOPE cruise team participants, their email contacts and their respective ship tasks are listed here below.

Family Name	Surnames	E-mail	Ship task
AMADO SAN JUAN	José Luis	JoseLuis.Amado@uab.cat	Po/Pb/Ac/Ra sampling, atm. dust and rain sampling
ARHAN	Michel	Michel.Arhan@ifremer.fr	CTD responsible
ARSOUZE	Thomas	thomas.arsouze@lsce.ipsl.fr	Fe IC/REE/Nd/Pa/230Th sampling
BARNES	Kirsten	Kirstb007@gmail.com	Sediment sampling & incubations, bacteria sampling
BOWN	Johann	Johann.Bown@univ-brest.fr	Co/Zn/Cd dissolved concentrations and organic speciation sampling ; GO-FLO sampling
BOYE	Marie	marie.boye@univ-brest.fr	co-Chief Scientist, PI of BGH for Geochemistry and Biogeochemistry, GOFLO casts responsible and sampling
BRANELLEC	Pierre	Pierre.Branellec@ifremer.fr	S/O2 sampling and analyses

BUCCIARELLI	Eva	Eva.Bucciarelli@univ-brest.fr	H2O2 analyses, Fe-Cu incubations ; GO-FLO sampling
CARDINAL	Damien	damien.cardinal@africamuseum.be	Si-isotopes, Si-incubations, and Ba sampling
CASACUBERTA	Núria	Nuria.casacuberta@uab.cat	Po/Pb/Ac/Ra sampling, atm. dust and rain sampling
CAVAGNA	Anne-Julie	acavagna@vub.ac.be	C-isotopes in specific compounds and biomarkers sampling
CHEVER	Fanny	Fanny.chever@univ-brest.fr	DFe, TDFe, SolFe sampling and analyses ; GO-FLO sampling
CORTES	Norbert	Norbert.Cortes@ifremer.fr	CPIES responsible, CTD
CORVAISIER	Rudolph	Rudolph.corvaisier@univ-brest.fr	BSi sampling, Si-incubations
DEHAIRS	Frank	fdehairs@vub.ac.be	Niskin casts responsible, Ba and 234Th sampling
DELILLE	Bruno	Bruno.Delille@ulg.ac.be	pCO2, DIC, TA sampling and analyses, responsible DIC
EZAT	Ullah	Ullah.Ezat@lsce.ipsl.fr	Alkenones, taxonomy and coccolithophorids sampling
FRIPIAT	François	francois.fripiat@africamuseum.be	Si-isotopes and Si-incubations sampling
GEILFUS	Nicolas-Xavier	nxgeilfus@ulg.ac.be	pCO2, DIC, TA sampling and analyses
GELAY	Amélie	Amelie.Gelay@obs-vlfr.fr	Pigments sampling
GLADYSHEV	Sergey	sgladyshev@ocean.ru	CTD shift
GONZALEZ-DAVILA	Melchor	mgonzalez@dqui.ulpgc.es	pCO2, pH, TA sampling and analyses, responsible pH
GROSSTEFFAN (FOLLENFANT)	Emilie	Emilie.grossteffan@univ-brest.fr	BSi sampling, Si-incubations
GUENEUGUES	Audrey	Audrey.Guenneugues@univ-brest.fr	Chl-a sampling and analyses
GUILLERM	Christophe	Christophe.Guillerm@ipev.fr	CTD shift, In situ pumps assistance
HALO	Issufo	Issufo.Halo@uct.ac.za	XBT's deployements
HAMON	Michel	Michel.Hamon@ifremer.fr	CTD shift
JOUBERT	Warren	wjoubert@csir.co.za	Primary production, nitrogen uptake rate, incubation with iron on N-uptake rates sampling
KERMABON - HEMON	Catherine	Catherine.Kermabon@ifremer.fr	CTD shift
KESTENARE	Elodie	elodie.kestenare@legos.obs-mip.fr	Log-book on CTD-Niskin frame, Daily operations report (Journal passerelle)
KEY	Erica	Erica.Key@cetp.ipsl.fr, ericalkey@gmail.com	Atmospheric physical sensors
LABORDE - TISNERAT	Nadine	Nadine.Tisnerat@lsce.ipsl-gif.fr	Carbon-isotopes sampling, DOC sampling
LACAN	François	lacan@legos.obs-mip.fr	Fe IC/ REE/Nd/Pa/230Th sampling ; in situ pump casts responsible
LAGADEC	Catherine	Catherine.Lagadec@ifremer.fr	CTD shift
LE BOT	Philippe	Philippe.Le.Bot@ifremer.fr	S/O2 sampling and analyses
LE BOYER	Arnaud	Arnaud.LeBoyer@univ-brest.fr	CTD shift
LE MOIGNE	Frédéric	fred.le.moigne@wanadoo.fr	Nutrients analyses
LEAU	Hélène	oceanopol@ipev.fr	OPEA-IPEV

LEIZOUR	Stéphane	Stephane.Leizour@ifremer.fr	Profiling floats responsible, CTD shift
MASSON-STROESSER	Annick	Annick.Masson@univ-brest.fr	Nutrients analyses
MELLET	Martin	Martin.Mellet@ipev.fr	IPEV assistance ingeener
MESSAGER	Christophe	Christophe.Messager@ifremer.fr	Meteo and atmos. balloons with physical captors
PASQUERO	Vincent	vincent.pasquero@free.fr	Carnet de bord, movie of the cruise
PASTOR	Lucie	pastor@ipgp.jussieu.fr	Sediment sampling & incubations
PERROT	Xavier	Xavier.Perrot@univ-brest.fr	LADCP
PERRUCHE	Coralie	Coralie.Perruche@univ-brest.fr	POC/PON/PIC sampling
PLANCHON	Frédéric	frederic.planchon@africamuseum.be	234Th sampling and analyses
RADIC	Amandine	radic@legos.obs-mip.fr	Fe IC/ REE/Nd/Pa/230Th sampling
REAUD	Yvan	yvan.reaud@laposte.net	IPEV assistance ingeener
RICHARD	Maxime	Maxime.Richard@univ-brest.fr	CFCs sampling
RIGAUT	Frédéric	Frederic.Rigaut@ipev.fr	IPEV computing responsible
RUPOLO	Volfango	Rupolo@casaccia.enea.it	S/O2 sampling and analyses, SST satellite images treatment
SANGIARDI	Pierre	Pierre.Sangiardi@ipev.fr	IPEV equipment responsible
SANTANA-CASIANO	Juana Magdalena	jmsantana@dqui.ulpgc.es	pCO2, pH, TA sampling and analyses
SARTHOU-ROUZO	Géraldine	Geraldine.Sarthou@univ-brest.fr	Fe(II) analyses, Fe-Cu incubations sampling
SCHEEL MONTEIRO	Pedro	pmonteir@csir.co.za	Primary production responsible, nitrogen uptake rate, incubation with iron on N-uptake rates sampling, Ar-O2 isotopes sampling and analyses
SCOUARNEC	Lionel	lscouarnec@ipev.fr	CTD shift, In situ pumps assistance
SPEICH-BLANKE	Sabrina	Sabrina.Speich@univ-brest.fr	co-Chief Scientist, PI of BGH for Physics
SWART	Neil	neil.swart@uct.ac.za	CFCs sampling
SWART	Sebastiaan	sebastiaan.swart@uct.ac.za	XBT's deployements and analyses
THOMALLA	Sandy	sandy_thomalla@yahoo.com	Primary production responsible, nitrogen uptake rate, incubation with iron on N-uptake rates sampling
VERDENY-COLOMINAS	Elisabet	Elisabet.Verdeny@uab.cat	Po/Pb/Ac/Ra sampling, atm. dust and rain sampling
VIOLLIER	Eric	viollier@ipgp.jussieu.fr	Sediment sampling, incubations and analyses, responsible of surficial multi-corer
WAKE	Bronwyn	bronwyn.wake@gmail.com	Multi-trace metals sampling, Zn-Fe-Co incubations sampling, GO-FLO sampling
WALDRON	Howard	howard.waldron@uct.ac.za	Primary production, nitrogen uptake rate responsible, incubation with iron on N-uptake rates sampling
ZEPPA	Pierre	pierre-zeppa@wanadoo.fr	Sediment sampling, incubations and analyses

OBJECTIVES

In the framework of the 4th International Polar Year (IPY 2008-2009), the BONUS-GOODHOPE project coordinated by M. Boye (Laboratoire des sciences de l'Environnement MARin, FR) and S. Speich (Laboratoire de Physique des Océans, FR) since 2006 aims at understanding the interactions between the oceanic dynamics, the geochemistry, the biogeochemistry and the atmosphere in the Southern Ocean and south-eastern Atlantic Ocean.

Interocean exchange plays an important role in global climate in response to variations of local or remote heat and freshwater fluxes via the thermohaline circulation. The Southern Ocean (SO) is a critical crossroad for this process as it provides an inter-ocean communication route for heat and freshwater (climate) anomalies, as well as anthropogenic tracers (Sloyan & Rintoul, 2001). The SO plays also a key role in the global carbon cycle due to unique features involving both physical circulation and biological processes. In particular, the outcropping of deep water masses allows for the exchange of gases such as CO_2 between the deep sea and the atmosphere, while the incomplete utilization of nutrients by marine phytoplankton in the HNLC area allows the concentration of CO_2 in the atmosphere to be substantially greater than would be the case if these nutrients were used efficiently. The polar-extrapolar communication of heat, freshwater and CO_2 helps to close the hydrological cycle through the production of Antarctic Intermediate Water and Subantarctic Mode Water (AAIW and SAMW). These water masses transport nutrients northward within the thermocline: by vertical mixing and advection, these nutrients could sustain a large part of the primary and export productions of the world ocean (up to 75%, Sarmiento *et al.*, 2004). Furthermore the uptake and storage of anthropogenic CO_2 within the ocean is controlled by circulation, where formation of AAIW, SAMW and Antarctic Bottom Water can provide a mechanism for uptake and transport of anthropogenic CO_2 (Caldeira & Duffy, 2000). Models indicate that the response of the SO to global warming will be a critical factor determining the ocean's future uptake of anthropogenic CO_2. However the scarcity of direct observations has greatly hampered our understanding of this environment. The challenge to understand SO dynamics (both physics and biogeochemistry) is exacerbated by the strong dynamic link between mesoscale processes and large-scale processes. The size of the SO and the impacts on global biogeochemistry and climate make this an important region.

BONUS-GOODHOPE main goals are :

1° Large scale monitoring and quantification of surface, mode and intermediate waters mass transport and ventilation in the southern hemisphere south of South Africa. Particular emphasis will be given to AAIW, SAMW and to the water properties of Agulhas rings and Cape Basin mesoscale structures.

2° Determination of the distributions of selected trace elements and isotopes (TEIs), evaluation of the sources and sinks of selected TEIs, and characterisation of the biogeochemical processes involved in the internal cycling of TEIs and the carbon cycle in the study area.

The general scientific approach has been based on the coupling of i) the physical oceanography ; with ii) the biogeochemistry, including nutritive trace metals (Fe, Co, Zn, Cu, Cd…), in the water-column, the atmosphere and the sediments and using on-deck incubations ; iii) the study of selected trace elements and isotopes, in the water-column and the sediments, that are tracers of lithogenic sources, of circulation, « ageing » and ventilation of water-masses, of biogeochemical processes, and that can be used to quantify the particulate export fluxes from the surface towards the deep waters ; iv) the atmospheric dynamics; and iv) with the later development of modelling that combine large and regional scales, idealized modelling, biogeochemical modelling, and simulations of trace elements and isotopes (Figure 1).

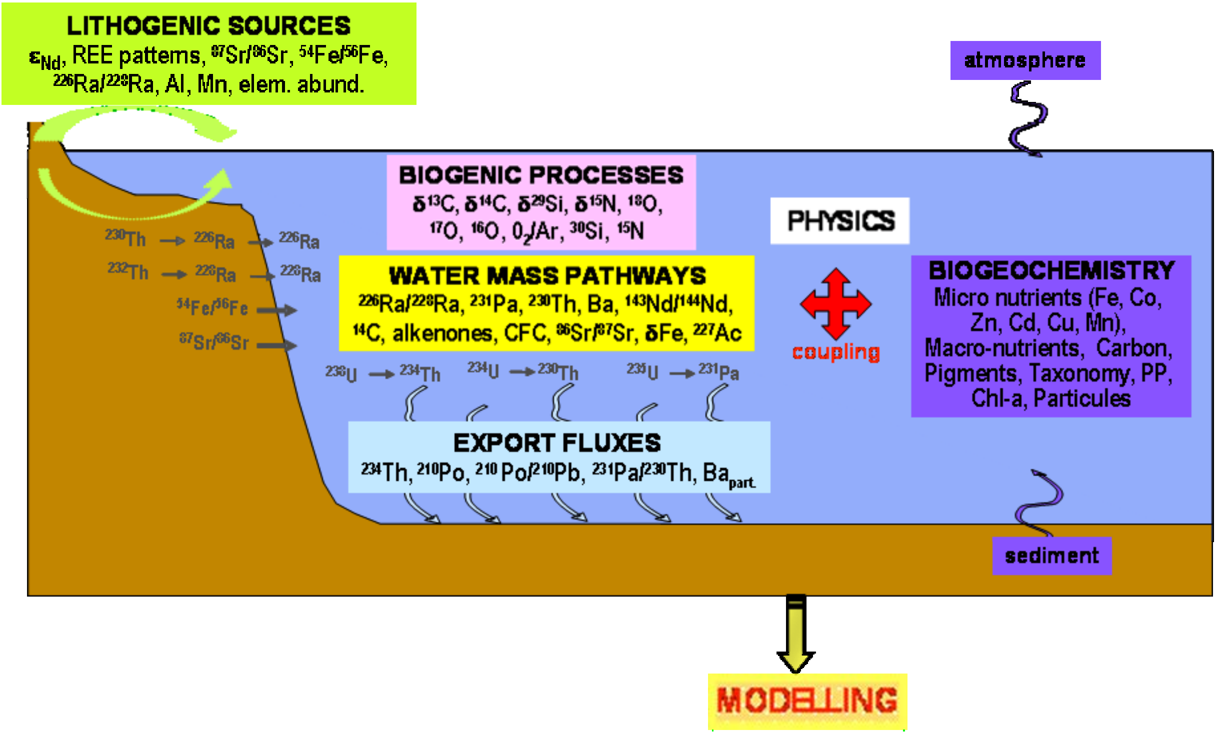


Figure 1- Scientific approach of the BONUS-GOODHOPE project *(figure courtesy M. Boye)*

The scientific objectives of BONUS-GOODHOPE project have been endorsed by the three IPY-clusters explorating the Polar Oceans : IPY-GEOTRACES (ID#269), IPY-ICED (ID#417), IPY-CASO (ID#132). It is also part of the international effort for the ocean observations at global scale within GEOTRACES and IMBER programmes.

The oceanic physics component of the Bonus-Goodhope project is a continuation of the pre-existing GOODHOPE project (started in 2004) coordinated by M. Arhan and S. Speich (LPO, FR). The Bonus-Goodhope project is a truly multidisciplinary project that combines the physics with the geochemistry, the biogeochemistry, and the different environments (seawater, atmosphere, sediment).

The Bonus-Goodhope project initially addressed the coastal-open ocean exchanges around and across the South-African continental margin. This objective should be fulfilled in a complementary cruise within the SACSO (South African Continental Slope Observations) project coordinated by X. Carton (LPO, FR) and M. Boye (LEMAR, FR).

The objectives and preliminary results of the oceanic and atmospheric physics are presented in a separate cruise report. In the *present cruise report, we focus on the geochemistry and biogeochemistry issues* of the BONUS-GOODHOPE project.

1. General context of the IPY and GEOTRACES

Our knowledge of ocean circulation and global biogeochemical cycles has a strong basis in the GEOSECS programme, conducted in the 1970s. This international joint venture was and still is the basis for understanding the distributions and biological roles of the dissolved inorganic carbon system, the major essential nutrient elements N, P, Si, as well as a small number of relevant isotopic tracers. The ensuing development of analytical techniques now allows studies of trace elements and their isotopes (TEIs) at concentration levels and at space and time resolution that were inconceivable during the GEOSECS era. Detailed mapping can thus be obtained of far more tracers, including their isotopic composition, with the potential to provide unique insights into a wide range of oceanic processes. This opportunity was the stimulus of the recently inaugurated GEOTRACES programme (http://www.geotraces.org).

In the framework of the International Polar Year (IPY) the international geochemical community (GEOTRACES) will bring together the best available techniques for a range of important TEIs. Within IPY, GEOTRACES therefore offers the ideal platform for a major internationally coordinated study of tracer distributions in polar waters to improve our understanding of the role of the polar oceans in the bio- and geo-chemical cycles.

The observational program of BONUS-GOODHOPE is furthermore part of a series of synoptic studies proposed in the framework of IPY in coordination with the programs IPY-GEOTRACES, IPY-CASO, IPY-ICED and CLIVAR. Strong collaboration with the IPY-GEOTRACES “ZERO&DRAKE” project (EoI#880, H. de Baar, NL) and its related IPY-GEOTRACES-CASO and CLIVAR cruise on board the German *RV Polarstern* (ANT-XXIV/3 cruise, chief scientist: E. Fahrbach, GR) that extends the section of BONUS-GOODHOPE on the zero-meridian from Polar Frontal Region towards the Antarctic continent will provide a full section of several TEIs between South Africa and Antarctica. Furthermore coupling the Indo-Atlantic connection south of Africa in BONUS-GOODHOPE with the Pacific-Atlantic connection at the Drake Passage in the *RV Polarstern* austral expedition will lead to significant advances in understanding the impact of the “warm route” and “cold route” of water masses transport (salts, heat, TEIs) on the thermohaline circulation that regulates earth climate to a large extend. The project has also strong links with the U.S. Antarctic IPY-GEOTRACES (EoI#271, B. Anderson, USA), and the GEOTRACES-CASO-Ocean Circulation IPY-CLIVAR/CLIC project (EoI#109, S. Rintoul and A. Bowie, Australia), as well as other international synoptic cruises in the Southern Ocean during the IPY.

2. Geochemistry and biogeochemistry sub-objectives

The geochemistry and biogeochemistry specific objectives of the Bonus-Goodhope project are divided into three main scientific themes:

a- The study of selected **Trace Elements and Isotopes** to further understand the distribution and internal cycles of trace metals; the origin, pathways and ventilation of the water-masses; the export fluxes, scavenging rates and remineralisation involved in the carbon cycle; and the biogeochemical cycles and processes.

b- The study of the air-sea CO_2 fluxes, the inorganic carbon vertical distribution, and the carbonate system to further assess the role of the Southern Ocean in the CO_2 overall sink.

c- To document several **biogeochemical parameters**, such as macro-nutrients, chlorophyll contents, and phytoplankton assemblages to further understand the biogeochemical functioning of the Southern Ocean.

The specific objectives of each themes and variables are described in details in the several cruise reports.

The three main themes together with the collaborations within the IPY in the Southern Ocean will provide new insights into the functioning and dynamics of the Southern Ocean and its climatic impact at large scale.

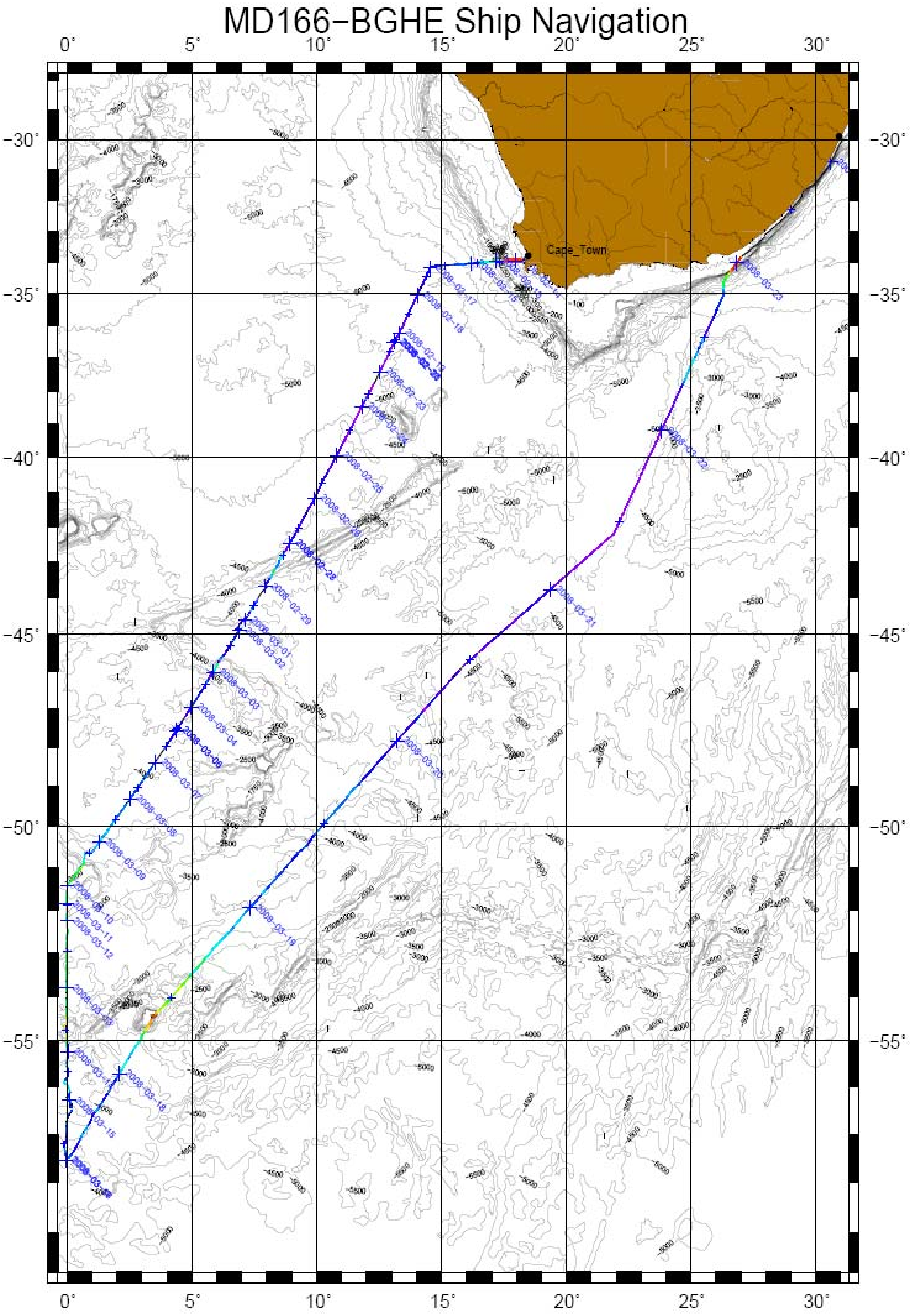
Other sub-objectives were reach during the Bonus-Goodhope cruise about intercomparison of GEOTRACES (TEIs) and CO_2 variables with the German *R.V. Polarstern*.

THE CRUISE

1. Cruise track

The multidisciplinary MD166 BONUS-GOODHOPE cruise tooks place in austral summer on board of the French *R.V. Marion-Dufresne II* in the south-eastern Atlantic Ocean with a first departure on the 08/02/13 from Cape Town (SA) towards the shelf region away of Cape Town at the isobath 200 m (Figure 2). We steamed back in front of Cape Town harbour on 08/02/15 to collect the Kevlar line and Teflon messengers that were forgotten at la Réunion. We then returned to the last sampled station and started the whole transect towards the atlantic sector of the Southern Ocean along the Greenwich Meridian at most 57°33 S (Figure 2). Reaching this position the transect back to Durban (SA) started on the morning of 08/03/17, and Durban was reached on 08/03/24 where the cruise ends up (Figure 2). The cruise track was within the area of 33°58' S 17°14' E towards 57°33' S 00°02' W.

The large-scale transect of BONUS-GOODHOPE lies very close to WOCE cruise tracks (A12 and A21) that was initially chosen within the pre-existing GOODHOPE physics project (starting with the russian first cruise in February 2004). This transect is, for the physics, an optimization of the repeated observations with altimetry sampling, past and present moorings deployment within the USA ASTTEX programme (University of Maine), the German WECCON project (Alfred Wagener Institut) and NOAA-AOML repeated high resolution XBT transects. Furthermore the selected BGH transect follows the JASON1 133 altimeters flight path, hence it efficiently increases the spatio-temporal sampling and observations. For the biogeochemistry and geochemistry, the transect encompasses stations of the GEOSECS programme and of expeditions both across the South Atlantic Antarctic Circumpolar Current, for which trace metals (DeBaar *et al.*, 1995, 1999; Löscher *et al.*, 1997, 1998; Boye *et al*., 2001; Ellwood *et al*., 2005), Be (Kusakabe *et al.*, 1982; Frank *et al.*, 2002), REE (Jeandel, 1993), Th, Pa (Rutgers van der Loeff and Berger, 1993), Ra (Hanfland, 2002), ^{227}Ac (Geibert, 2001), radiocarbon (Leboucher *et al*., 1999), silicon isotopes (Cardinal *et al*., 2005) were measured, but no systematic coordinated tracers study has been made as it is developed in Bonus-Goodhope. Finally the Bonus-Goodhope transect is part of a series of synoptic studies proposed in the framework of IPY-Southern Ocean in coordination with GEOTRACES and CASO programs. Especially the IPY-GEOTRACES “ZERO&DRAKE” project (EoI#880, H. de Baar, The Netherlands) on board of the German research vessel *Polarstern* (ANT-XXIV/3 cruise) extends the section of BONUS-GOODHOPE along the Greenwich meridian to acquire a complete section of several Trace Elements and Isotopes from the sub-tropical region towards the Antarctic Peninsula in the atlantic sector of the Southern Ocean.



MD 2008 Mar 24 07:26:04 FR/T2I/IPEV MD166−BGHE From 08−02−13T00:33:00 To 08−03−24T05:07:07 (Bathymetry scale : 0 to −5500m)

Figure 2- Daily ship track of the MD166 BONUS-GOODHOPE cruise

2. Sampling strategy and stations position

Type of stations

Three main types of station were defined by series of operations deployed at sea as following:

➢ **HYDRO station** (black crosses in Fig.3): 1 CTD-Niskin frame cast from the surface to the bottom, with 22 sampling depths.

A total of *67 HYDRO* stations were achieved during the cruise.

➢ **LARGE station** (blue crosses in Fig.3):

●1 CTD-Niskin frame cast from the surface to the bottom, with 22 sampling depths; 1 CTD-Niskin cast from the surface to the base of the mixed layer and 1 GO-FLO cast from the surface to about 2000 m with 10 depths (e.g., **LARGE-type a**). A total of 3 LARGE-a stations were done.

●Additionally 4 **LARGE-b** stations were done with 3 CTD-Niskin casts (1 from the surface to the bottom, 1 within the mixed-layer, 1 from the surface to 1000 m) and 1 GO-FLO cast (from 0 to 2000 m).

So a total of *7 LARGE* stations have been achieved.

➢ **SUPER station** (red crosses in Fig.3): generally 5 CTD-Niskin casts (2 casts 0-bottom, 1 cast 0-mixed layer, and 2 casts 0-1000 m), 6 GO-FLO casts (0-2000 m, 2000-4000 m, 0-mixed layer, and 3 casts in the fluorescence maximum), 2 In situ Pumps casts (2 times 0-bottom) and 1 cast with the multicorer were realised.

A total of *5 SUPER* stations were achieved during the cruise.

For the several station-types (HYDRO, LARGE and SUPER) and other operations at sea (such as XBTs deployement), the exact positions, dates, and timing of the loading and recovering are reported in the report of the cruise log-book (“diary operations”; E. Kestenare and M.P. Torre).

Sampling strategy

The cruise track crosses the several frontal systems of the Antarctic Circumpolar Current (ACC), that are southward: the SubTropical Front (STF; 42°2’S), the SubAntarctic Front (SAF; 44°2’S), the Polar Front (PF; 50°22.4’S), the Southern ACC Front (SACCF; 51°52’S), and the Southern Boundary of the ACC (SBdy; 55°54.3’S). The position of the principal branches of each front has been defined on board by applying mean CTD (e.g., the potential temperature from which the positions of the fronts here above are derived), satellite imagery (altimetry, SST) and XBT recorded data. The narrow jets and fronts separate several oceanic provinces that distinguish each other by their surface horizontal hydrological and biogeochemical properties. Namely the subtropical region is north of the STF (<42°2’S), the subantarctic domain is between the STF and SAF, the Polar Frontal Zone is between the SAF and PF, the HNLC region ("High Nutrients-Low Chlorophyll") starts south of the PF, and the southern part of the cruise track (>55°54’S) is the region of the Weddell Sea gyre. The horizontal sampling strategy for the geochemistry and biogeochemistry parameters in the water column and sediments covers all the very important oceanic provinces encountered along the transect, with a refined resolution, when possible, near and at the fronts and within mesoscale dynamical structures such as eddies originated from the Agulhas Bank or the subantarctic region. For instance the eastern edge of an Agulhas anticyclone was sampled in the subtropical domain (e.g., station 18 - SUPER 1); a small cyclone (called "cyclone S") was crossed just south of the STF in the subantartic region (e.g., at about station 15), and a very large and intense "anticyclone M" of Indian origin just on the southern side of the Agulhas Ridge (e.g., at station 36).

The applied vertical resolution encompasses the productive layer, the nutricline, the mixed layer, and the several water-masses encountered in the water column of the transect. Notably in the vicinity of the continental margin and shelf break near Cape Town the surface warm and salty waters of the Agulhas jet was detected, and the subtropical warm and salty water of Indian origin when leaving the 200 m isobath and a layer of AAIW of Indian origin at about 800-1000 db. Along the slope, the salinity and oxygen maximum between 2300 and 3200 db feature the deep southward slope current of diluted North Atlantic Deep Waters (NADW). The bottom topography along the transect is marked by the Agulhas Ridge that is roughly between 40-45°S and 5-15°E (Figure 2), and that was crossed between 08/02/28 and 08/02/29. The STF is located north of this ridge. North of this Ridge in the subtropical region, the several water masses detected in deep waters are the Upper Circumpolar Water (UCDW) characterized by its oxygen minimum centred at around 1200 m and circulating north-westward along the transect, the North Atlantic Deep Water (NADW) with its salinity maximum below the UCDW circulating south-eastward along the transect, and underneath in the Cape Basin abyssal plain, probably a diluted variety of Antarctic Bottom Water (AABW) flows following the bottom topography. In the subtropical region of the transect, a layer of Antarctic Intermediate Water (AAIW) of Indian origin characterized by salinity minimum and oxygen maximum was also detected centred at around 700-750 m (e.g., at about stations 11 to 34). South of the Agulhas Ridge and the "anticyclone M", the transect entered in the principal branch of the SAF (e.g., station LARGE 3b). In this northern branch of the SAF, a layer of subantarctic surface waters was depicted between 100-150 m. Underneath waters with salinity minimum, or that we call the "SubAntarctic Mode Water" (SAMW), were sampled with their center at around 400 m, as well as UCDW (oxygen minimum) centred at around 1400 m and the upper NADW and Lower Circumpolar Deep Water (LCDW) below about 2000 m. At the bottom the colder AABW was found. At the southern frontier of the SAF (e.g., station LARGE 4a) SAMW is being formed and subducts between 80-300 m depth. In the Polar Frontal Zone just north of the Polar Front (e.g., station LARGE 5b), in the Polar Front (e.g., station LARGE 6a) and just south of the Polar Front (e.g., station SUPER 4), the cold Antarctic Winter Water was detected between 140-180 m; and the “classical” water-masses at deepest depths (e.g., UCDW flowing southward; LCDW flowing southward and AABW flowing northward in the bottom). The Winter Water is flowing northward in the region north of the SBdy, and it subducts at the Polar Front to form the Antarctic Intermediate Water (AAIW). The station LARGE 7b is north of the SBdy, and the Winter Water is detected at around 100-120 m at this station. South of the SBdy in the region of the Weddell Gyre (e.g., station SUPER 5), the water masses that classically fill the water column of the Weddell Gyre are observed. Here the Winter Waters are between 120-190 m.

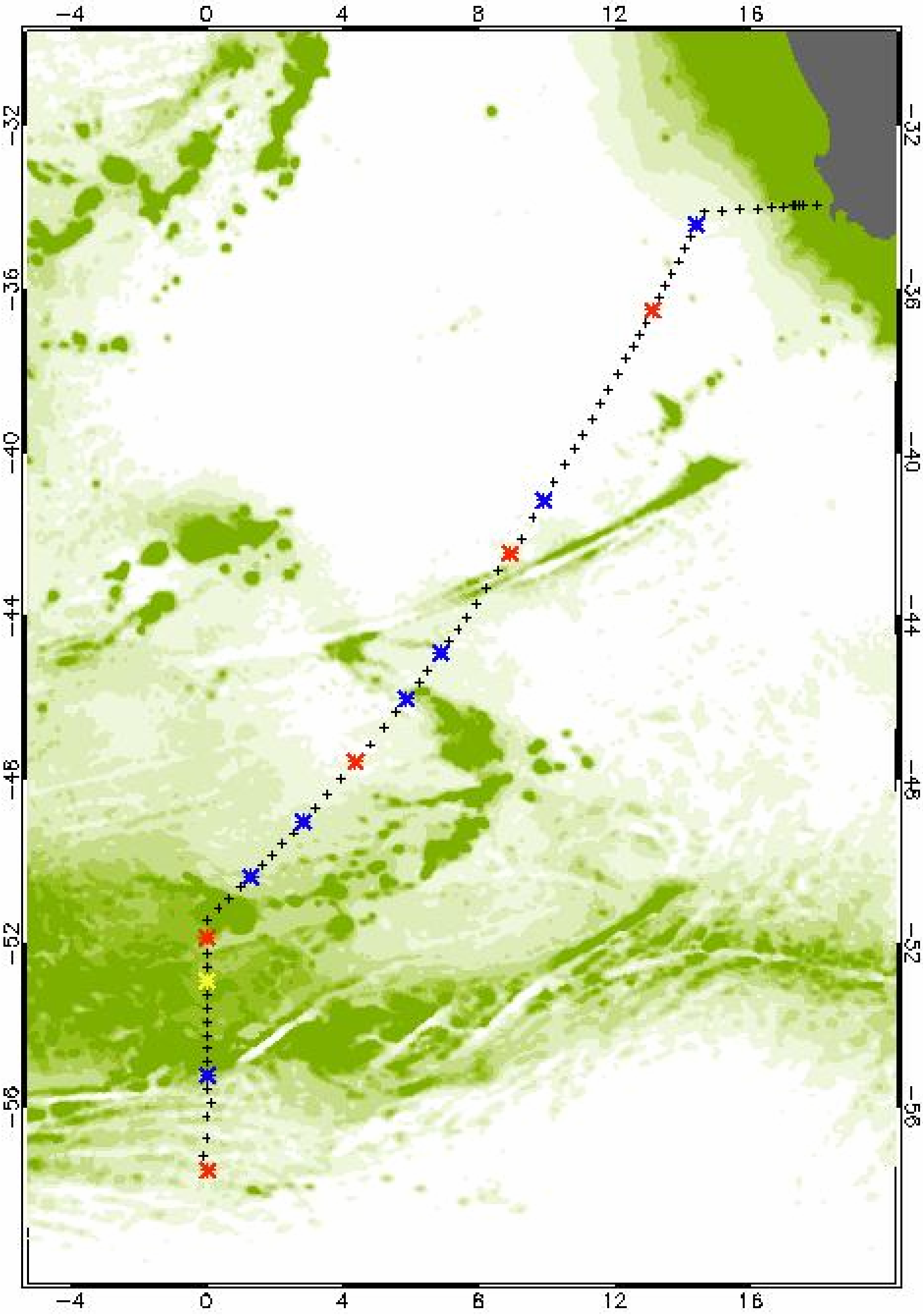


Figure 3- Stations position for the geochemistry and biogeochemistry parameters along the BGH transect (colour code: black= HYDRO, blue= LARGE, red= SUPER).

Note: the yellow cross is part of one GEOTRACES intercomparison excercice stations.

3. Sampled parameters

The list of the geochemical and biogeochemical parameters sampled at each station and cast is reported in the several log-books of the CDT-Niskin Frame (E. Kestenare and M.P. Torre, Annexe 1), of the In situ pumps (A.J. Cavagna, Annexe 2), and of the GO-FLO (M. Boye, Annexe 3). The samples taken in the sediments and the atmosphere, as well as in surface waters along the transect are detailed in the individual cruise reports (respectively, E. Viollier; A. Baker; and B. Delille and N.X. Geilfus; E. Verdeny et *al*; P. Monteiro et *al*.).

4. Comparative schedules

A. Schedule proposed in the funded proposal (LEFE 2007-2011 ; ANR 2007-2010)

Capetown-Capetown, 0°W at 57°S

Type of stations	Number of station	Time per station (hours)	Time (days)
HYDROGRAPHIC	54	4	9
LARGE	20	9	7.5
SUPER	6	28	7
Total station time			23.5
Seasor survey			3.5
Transit time up to 57°S			7
Ship operations time			34
Total shiptime for LEG-1		(+7d transit back)	41

B. Available shiptime (IPEV letter, 07/12/06)

The ship departure will be on 08/02/09 late evening from Capetown, and the return on 08/03/24 in Durban (e.g., 44 full days of shiptime).

C. Schedule proposed in the last pre-cruise meeting (08/01/10)

The schedule given by IPEV :
- 7, 8, 9 Feb. 2008: Marion Dufresne in CapeTown harbour
- 9 Feb. until 17 March: Bonus-Goodhope stations and operation at sea (eg, 38 days in the sampling area)
- 18 until 23 March: transit to Durban (6.5 days to reach Durban on 08/03/24)
- 24 March: unloading of equipments and scientists in Durban

Capetown-Durban, 0°W at 60°S

Type of stations	Number of station	Time per station (hours)	Time (days)	Δ(funded-Jan.08) (days)	Δ(IPEV-Jan.08) (days)
HYDROGRAPHIC	70	3.5	10.21	+ 1.21	
LARGE-type A	14	4.6	2.68	- 3.05	
LARGE-type B	6	7.1	1.77		
SUPER	6		11.8	+ 4.8	

MARGIN station	1	12	1	+ 1	
GEOTRACES intercomparison	1	7.5	0.31	+ 0.31	
Total station time			27.77	+ 4.27	
Transit time up to 60°S			8	+ 1	
Ship operations time			35.77	+ 1.77	+ 2 (38 – 35.77)
Transit time to Durban			6.5	- 0.5	
Total shiptime for LEG-1			42.27	+ 1.27	+ 1.7 (44 – 42.3)

D. Achieved schedule

- 7-13 Feb. 2008: Marion Dufresne in CapeTown harbour
- 13 Feb. (noon) until 17 March: Bonus-Goodhope stations and operation at sea (eg, 34.5 days in the sampling area, including transects to pick up the cable in front of Capetown)
- 17 March (noon) until 23 March: transit to Durban
- 24 March: Durban harbour

Capetown-Durban, 0°W at 57°33 S

Type of stations	Number of station	Time (days)	Δ(Done-Jan.08/IPEV)	Δ(Done-funded)
HYDROGRAPHIC	67		- 3 st.	+ 13 st.
LARGE-type A	3		- 11 st.	- 13 st.
LARGE-type B	4		- 2 st.	
SUPER	5		- 1 st.	- 1 st.
MARGIN station	0		- 1 st.	
GEOTRACES intercomparison	1		0 st.	
Ship operations time		34.5	- 3.5 d (and about - 20H transit for the cable)	+ 0.5 d

PRELIMINARY RESULTS

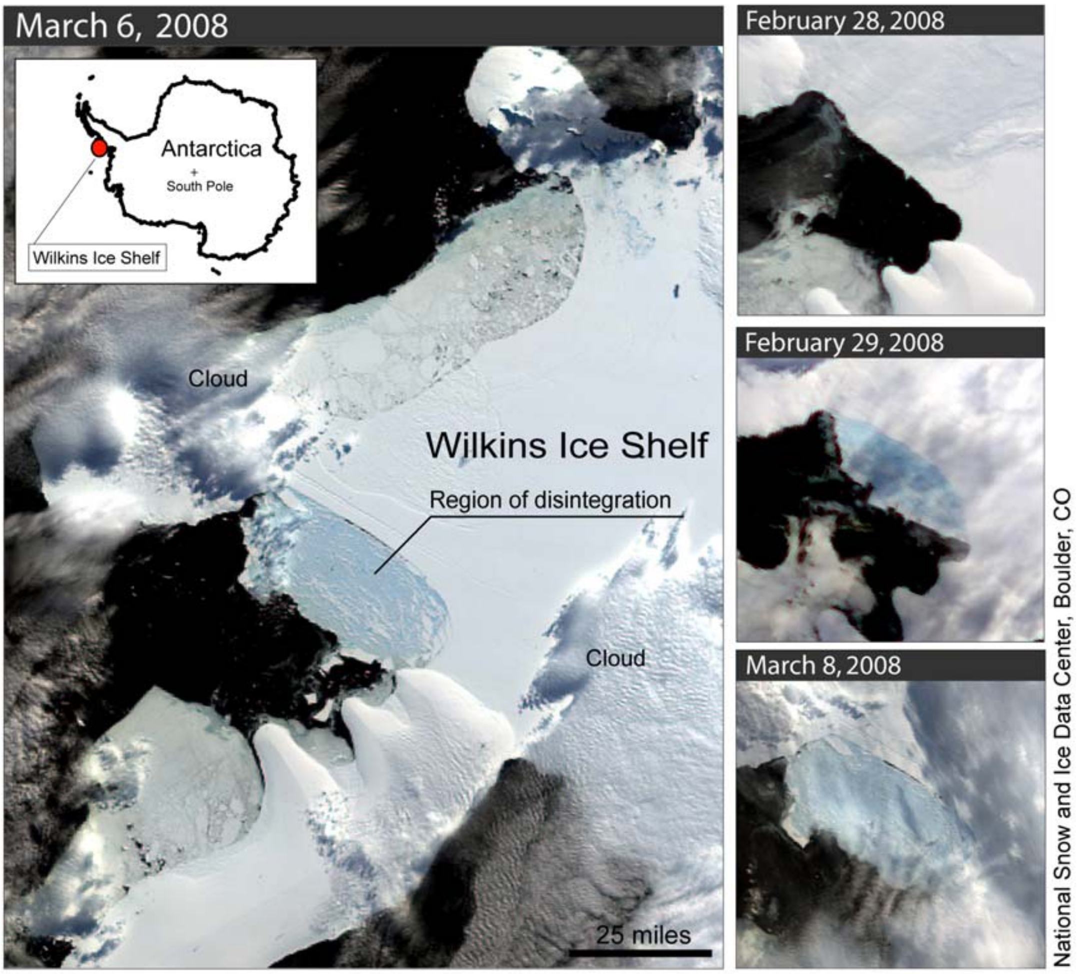
The Southern Ocean acts as an overall sink for atmospheric CO_2 where the primary production at mid-latitudes overrides the CO_2 outgassing of upwelling deep waters at higher latitudes. Furthermore the subduction of mid-latitude mode and intermediate waters and the deep-water formation at high-latitudes in the Weddell Sea constitute a major pathway for anthropogenic CO_2 penetration in the ocean interior. The inventory of the anthropogenic CO_2 in the Southern Ocean could be much larger than previously estimated. The transport of nutrients by the mode and intermediate waters could furthermore control the thermocline nutrients and biological productivity at lower latitudes (Sarmiento *et al*., 2004). The Southern Ocean provides also an inter-ocean communication route for heat and freshwater anomalies, as well as anthropogenic tracers, hence it plays an important role in global climate. The water-masses transport and the biogeochemistry of the Southern Ocean are thus key issues to further understand the impact of the Southern Ocean on the global climate stability. However the Southern Ocean is remote and understanding his functioning is still lacking by the scarcity of direct observations. Our scientific approach, based on the coupling of selected trace elements and isotopes, biogeochemical key-parameters and physics has thus been applied to further understand the dynamics of the Southern Ocean.

The preliminary results show meridian gradients of macro- and micro-nutrients with a general southward increase of macronutrients and decrease of iron in the surface layers, respectively. These gradients are linked with meridian gradient of chlorophyll-a with generally higher chl-a contents in the subsurface waters of the subtropical and subantarctic regions, thought the levels were low (<= 0.5 microg l^{-1}). It is suggested that the subtropical and subantarctic regions displayed a post-bloom situation, while the signs of a pre-bloom were depicted at the southern side of the transect, in the Weddell Gyre. Late summer development of phytoplankton in the Weddell Gyre could be driven by sea-ice melting, provided the sea-ice is a source of nutrients as it was recently demonstrated (Smith *et al*., 2007). The detailed mapping of macro- and micro-nutrients in the Weddell Gyre associated with tracers of sources will either confirm or reject such hypothesis. At the Polar Front, the large diatom blooms generally reported in this area (Bathman *et al*., 1997; de Baar *et al*., 1997) were already finished during our cruise in the austral summer. Obviously the complementary tracers of the particulate carbon export (such as ^{234}Th, ^{210}Pb/^{210}Po) will thus bring crucial and new information on the carbon export through the biological pump in the Polar Front.

Additionnaly the results demonstrate that the macro-nutrients could serve as tracers of water-masses in this region, especially the Mode Waters and Antarctic Intermediate Waters with a negative Si* (as defined in Sarmiento *et al*., 2004); and of dynamical structures such as eddies, especially the anticyclonic "eddy-M" crossed on the southern side of the Agulhas Ridge.

Significant changes of the partial pressure of CO_2 (pCO_2) were gathered accross fronts and eddies. An overall undersaturation in surface seawater CO_2 was recorded in the subtropical area, while the subantarctic and Polar Frontal zones were below or near the saturation. The warmer surface waters and remineralization of organic matter could explain the significantly higher pCO_2 encountered in the subantarctic region during summer compared to spring season. South of the Polar Front it is suggested that upwelling of CO_2 rich subsurface waters may contribute to the oversaturation in pCO_2. Later data proceeding will allow to assess the relationships between air-sea CO_2 fluxes, biological activity and carbon export especially in the mid-latitude zone; as well as to make the inventory of anthropogenic CO_2 and to further determine the contribution of Mode and Intermediate Waters subduction to the overall anthropogenic penetration.

Finally several icebergs were seen at latitudes near 47°S that could be an underscore of Global Warming in the Southern Ocean. Satellite pictures (National Snow and Ice Data Center-NSIDC, and NASA) taken between 08/02/28 and 08/03/08 shown that 405 km^2 of the Wilkins ice-shelf disintegrated during that period (Picture 2). The detachment of an iceberg of 41 km long and 2.5 km wide on 08/02/28 could be at the origin of this disintegration. It is possible that the icebergs we have crossed at 47°S around March 5-6th 2008 resulted of the drift of this iceberg pieces.



Picture 2- Ice-shelf disintegration of the Antarctic Peninsula (NSIDC/NASA)

Trace elements and isotopes

Most of the samples to allow the determination of trace elements concentrations, speciation and isotopic compositions have been stored for later analyses in the respective laboratories. Onboard analyses of dissolved iron concentrations indicate that the “clean” device arranged to collect the trace metals samples was not introducing contamination, at least for iron (see Report of Chever *et al.*). The dissolved iron concentrations display typical open ocean profile and the recorded concentrations in the HNLC region were as low as those previously published in this area (such as Boye *et al.*, 2001). The study of the redox cycle of iron suggests that iron(II) stage could primarily exist as particulate (see Report of Sarthou *et al.*). The redox cycle of iron involves the production of hydrogen peroxide (H_2O_2). It was reported that the production of H_2O_2 might involve the activity of phytoplankton during day-light (e.g., through photosynthesis; see Report of Bucciarelli *et al.*).

The biogeochemical meridian gradients

The primary production and phytoplankton assemblage that drives the main conduit of the biological pump is characterized in the Antarctic Circumpolar Current and the subtropical region by meridian and seasonal gradients. Typically late spring diatoms blooms are recorded in the vicinity of the Polar Front (Smetacek *et al.*, 1997), and massive deposits of coccoliths are found north of the Polar Front (< 50°S; Honjo, 1997), but coccolithophorids seem to not be flourishing in the Antarctic Ocean proper (> 50 °S). The depletion of silicon is the obvious reason why initially smaller diatom taxa may be found in the Polar Frontal Zone and more northwards no diatoms should not be found at all anymore (see Report of Le Moigne *et al.* for the silicon). However it is not know what prevents the coccolithophorids from blooming at high latitudes (> 50°S). The preliminary results show meridian gradients of macro-nutrients with a general southward increase of macronutrients in the surface layers (see Report of Le Moigne *et al.*). These gradients are linked with meridian gradient of chlorophyll-a with generally higher chl-a contents in the subsurface waters of the subtropical and subantarctic regions, thought the levels were low (<= 0.5 microg l^{-1}; see Report of Guenneugues and Boye). The examination of several biogeochemical parameters (phaeopigments, ammonia, chlorophyll-a, macronutrients) suggests that the subtropical and subantarctic regions were in a post-bloom situation, while the signs of a pre-bloom were depicted in the Weddell Gyre (see Reports of Guenneugues and Boye; Le Moigne *et al.*). At the Polar Front, subsurface maximum of ammonia (1.5 microM) together with extremely low levels of chl-a, phaeopigments and silicon all suggest that large diatom blooms generally reported in this area (Bathman *et al*., 1997; de Baar *et al*., 1997) were already finished in the austral summer. The later analyses of phytoplankton assemblages, primary production, macro-nutrients uptake rates, trace metals deck incubations, etc.. will allow a better understanding of the biogeochemical functioning of the Southern Ocean, especially it will highlight the co-limitations by means of macro- and micro-nutrients. The combination of these issues with the multi-proxy approach will also tell more about the functioning of the biological carbon pump in the several biogeochemical provinces crossed by the transect.

Carbon dioxide

The partial pressure of CO_2 (pCO_2) ranged from 325 to 415 ppmv in the surface waters of the transect (see Report of Delille and Geilfus). Significant changes of pCO_2 were gathered across fronts and eddies. An overall undersaturation in surface seawater CO_2 was recorded in the subtropical area, while the subantarctic and Polar Frontal zones were below or near the saturation and the polar open oceanic region was oversaturated (see Report of Delille and Geilfus). Comparison with a previous cruise in spring suggests that the significantly higher pCO_2 encountered in the subantarctic region during Bonus-Goodhope may be due to warmer surface waters and remineralization of organic matter. The latter is in agreement with a post-bloom situation depicted in the subantarctic region. South of the Polar Front it is suggested that upwelling of CO_2 rich subsurface waters may contribute to the oversaturation in pCO_2. The increase of dissolved inorganic carbon (DIC) over the first thousand meters is related to mesopelagic biomineralisation, while below 1000 m DIC concentrations are typical of each water masses body (see Report of Delille and Geilfus). In the Weddell Gyre, the increase of DIC towards the bottom mimics the increase of oxygen, and the highest DIC concentrations was found in the top 1000 m of this area of the transect. Later data processing in combination with multi-proxy approach will allow to further assess the relationship between the biological carbon pump and the air-sea CO_2 fluxes in the mid-latitude zone. Inventory of anthropogenic CO_2 and determination of the contribution of Mode and Intermediate Waters subduction to the overall anthropogenic penetration will also be assessed.

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TRACE ELEMENTS AND ISOTOPES

1. GEOTRACES VARIABLES of Bonus-Goodhope

Marie BOYE (marie.boye@univ-brest.fr)
LEMAR- IUEM- Technôpole Brest Iroise- FR-29280 Plouzané

GEOTRACES variables

Onboard: José-Luis Amado, Thomas Arzouse, Johann Bown, Marie Boye (Responsible), Eva Bucciarelli, Damien Cardinal, Núria Casacuberta, Anne-Julie Cavagna, Fanny Chever, Rudolph Corvaisier, Frank Dehairs, Ullah Ezat, François Fripiat, Emilie Grossteffan, Warren Joubert, François Lacan, Pedro Monteiro, Frédéric Planchon, Amandine Radic, Géraldine Sarthou, Sandy Thomalla, Nadine Tisnérat-Laborde, Elisabet Verdeny, Howard Waldron, Bronwyn Wake.

Not onboard: Eric Achterberg, Alexander Baker, Michael Bender, Nicolas Cassar, Peter Croot, Eric Douville, Walter Geibert, Claudia Hanfland, Gideon Henderson, Catherine Jeandel, Rémi Losno, Pere Masquè, David Nelson, Philippe Pondaven, Sonja Ripperger,Matthieu Roy-Barman, Marie-Alexandrine Sicre, Constant van den Berg.

General objectives

One major aim of international GEOTRACES (http://www.geotraces.org) is:

"To determine global ocean distributions of selected trace elements and isotopes, including their concentration, chemical speciation, and physical form, and to evaluate the sources, sinks, and internal cycling of these species to characterise more completely the physical, chemical and biological processes regulating their distributions".

The international Polar Year is an excellent opportunity to study the Trace Elements and Isotopes in Polar Oceans, since an international suite of vertical sections is integrated in the IPY project N°35 (http://www.ipy.org/development/eoi/proposal-details.phd?id=35) entitled "International Polar Year GEOTRACES: An International study of the biogeochemical cycles of Traces Elements and Isotopes in the Artic and Southern Oceans".

In the framework of this IPY-GEOTRACES, the BONUS-GOOHOPE project and cruise are providing a suite of various Trace Elements and Isotopes in the water-column, the atmosphere and the sediments of the Southern Ocean and the south-eastern Atlantic Ocean. Some of these Trace Elements and Isotopes have been previously study in the near section of BGH, while the northern part of the transect (e.g., north of the SubAntarctic Front) is poorly documented so far. Others are still in the exploratory stage, such as the iron-isotopic composition and the cadmium-isotopic composition. The unique combination of multi-tracers approaches, and the intracomparison exercices for selected Trace Elements that were achieved in BGH should provide new steps forward into the calibrations of tracers, especially those for carbon export; as well as methodology developments. Additionally on deck incubations have been conducted using bioassays with Trace Elements and Isotopes, hence providing a more complete understanding of the physical, chemical and biological processes regulating the distributions of these elements.

Work at sea

Trace Elements and Isotopes

Trace Elements and Isotopes (TEI's) have been collected in seawater either with GO-FLO bottles suspended on a Kevlar wire on the 7 LARGE stations and 5 SUPER stations, or with In Situ Pumps (Mac Lane and Challenger) on the 5 SUPER stations, or with Niskin bottles modified with internal Teflon springs on most of the stations for some of the TEI's such Ba (see Annexes 1-3), or sporadically using the ship-intake water supply (see Reports of Verdeny et *al.*, Ezat et *al.*, Monteiro et *al.*).

In sediments TEI's have been collected with an Oktopus Gmbh multiple corer (head version MUC 8/100) equipped with 8 transparent polycarbonate cylinders on the SUPER stations when efficient (see Report of Viollier et *al.*).

In the atmosphere TEI's in the aerosols were collected continuously using a high-volume (1 m^3 min^{-1}) sampler equipped with a bulk aerosol sampling head (Whatman 41 filter), while in the rain they were collected very sporadically on an event basis by deploying large (40 cm diameter) plastic funnels for the duration of rainfall only (see Report of Baker et *al.*).

A rough summary of the GEOTRACES parameters sampled during the BONUS-GOODHOPE cruise is given in Table 1. The details of the sampling list and responsibles are given in the Annexes 1-3, in the various reports and in the Dictionary.

Table 1 – Summary of the GEOTRACES parameters sampled during the BONUS-GOODHOPE cruise

Stations:	HYDRO	LARGE		SUPER				Ship Intake water	ATMOSPHERE	
GEOTRACES PARAMETER Device:	Niskin	Niskin	GoFlo	Niskin	GoFlo	In situ Pump	Corer		dust	rain
Trace metals concentration (Fe, Zn, Al, Cd, Co, Éetc)			70 diss. + 70 unf.		100 diss. + 100 unf.		Yes		Yes	Yes
Trace metal organic speciation (Fe, Zn, Co, Cd, Cu)			70 dissolved		100 diss.					
Trace metal redox speciation (Fe)			70 unfiltrated		100 unf.					
Trace metal physical speciation (Fe)			30 soluble		40 soluble					
CdIC					50 diss.		Yes			
FeIC					49 diss. + 49 filters		Yes			
εNd, ^{231}Pa, ^{230}Th, REE				55 diss.+ 55 filters		33 filters	Yes			
^{210}Po/^{210}Pb		62		76		56 filters	Yes			
^{14,13,12}C in POC						67 filters	Yes			
^{234}Th				97		67 filters	Yes			
δ^{13}C in specific compounds						67 filters	Yes			
^{226,228}Ra, ^{227}Ac		1		7		20 cartridges		Discrete samples		
Alkenones						7 filters	Yes	Discrete samples		
δ^{30}Si in Bsi		21		15		48 filters	Yes			
δ^{30}Si in dissolved-Si		76		95						
Dissolved Ba	Few st.	154		110			Yes			
Authigenic Ba (barite)		88		110						
Boron		45		60						
$^{16,17,18}0_2$/Ar	35							Under-way samples		

On-deck incubations

Large volumes sampled with the Niskin bottles at the Large-type B stations have been incubated with ^{13}C for deck incubations to investigate the primary production (see Report Monteiro et *al.*); with ^{15}N to study the nitrogen uptake (see Report Monteiro et *al.*), and with ^{30}Si to investigate the uptake rate of Si and dissolution rate of biogenic silicon (see Report Corvaisier, Grossteffan, Cardinal & Fripiat).

Trace metals clean sampling using GO-FLO bottles have been used for on deck bioassays testing the zinc-iron-cobalt (co-)limitations at 4 SUPER stations (Annexe 3 ; see Report Wake & Boye), testing the iron-copper (co-)impacts at 4 SUPER stations (Annexe 3 ; see Report Sarthou et *al.*), and testing the impact of iron on nitrogen uptake at 3 SUPER stations (Annexe 3 ; see Report Monteiro et *al.*).

2. DISTRIBUTION AND INTERNAL CYCLE OF TRACE METALS

2.1. Report on GO-FLO's samples and trace metals on deck incubations

Marie BOYE (marie.boye@univ-brest.fr)
LEMAR- IUEM- Technôpole Brest Iroise- FR-29280 Plouzané

GO-FLO samples

Onboard: Johann Bown, Marie Boye (Responsible), Eva Bucciarelli, Fanny Chever, Warren Joubert, Pedro Monteiro, François Lacan, Amandine Radic, Géraldine Sarthou, Sandy Thomalla, Howard Waldron, Bronwyn Wake. *Not onboard*: Eric Achterberg, Peter Croot, Gideon Henderson, Rémi Losno, Sonja Ripperger, Constant van den Berg.

Trace Elements and Isotopes sampled with GO-FLO's bottles

Sampling strategy

The stations positions were selected in order to cover at most the vertical distribution of TEI's in the interfrontal regions crossed by the transect, as well as some of the frontal systems, the region of the Mode Waters formation and an anticyclonic eddy originated from the Agulhas Current retroflexion (e.g., SUPER-1 station). The sampling depths were selected to characterise the several water masses encountered in the water column, especially the Mode Waters, the Antarctic Intermediate Waters, the North Atlantic Deep Waters and the Circumpolar Deep Waters.

Ultra-clean sampling

The water samples for trace metals (Zn, Fe, Co, Al, ….), isotopes (Fe-IC; Cd-IC), and trace-metals on deck incubations were collected with 10 pre-cleaned 12 L GO-FLO bottles (LEMAR, FR) suspended to a Kevlar wire (NIOZ, NL). The Kevlar line was rolled up on a freshly epoxy-coated winch (IPEV) and operated with three trace-metal free pulleys (one directional for the winch, one of "return", and one counting-pulley). 10 depths were sampled at the 7 LARGE stations between surf.-2000 m and 20 depths at the 5 SUPER stations between surf.-4000 m for the trace metals by a mean of two Go-Flo casts, while only the 5 SUPER stations where sampled for the Fe and Cd-IC, and 3 to 4 SUPER stations at the maximum of fluorescence for the trace metals incubations (Annexe 3).

Wire angle correction will be made using the "Microcat" depth sensor that was attached to the bottom of the line when maximal depth permitting (> 3500 m). Depth will further be calibrated using the nutrients analyses that were made in selected GO-FLO bottles.

The GO-FLO bottles were closed by means of Teflon messengers, and where placed in a trace-metal clean container (INSU) after retrieval.

The samples were filtered using 0.2 microm polycarbonate cartridges SARTOBAN Sartorius© for dissolved trace metals and dissolved Cd-IC; using 0.4 microm polycarbonate filters mounted in a Teflon filter holder for dissolved and particulate Fe-IC; and using prescreens (200 µm) for the incubations. All filtrations were made directly from the Teflon tape Go-Flo bottle under a free-metal nitrogen pressure of 0.1 bar.

Preliminary results of dissolved iron concentrations recorded on board indicated that the whole device and the sampling procedure were not introducing contamination for this element (see Report Chever et *al.*).

Scientific subprojects achieved with the GO-FLO sampling

The scientific topics achieved with collecting samples using the ultra-clean GO-FLO and device (Kevlar line and epoxy-coated winch) are listed here below. The objectives of each sub-topic and preliminary results when available are in the several reports, except for subtopics 4, 6, 8, 9 and 10. The details of the sampling list, station positions and depths are all reported in Annexe 3.

Subproject 1: dissolved and particulate multi-trace metals distribution in the Southern Ocean (*B. Wake, M. Boye, E. Achterberg*)

Subproject 2: particulate, dissolved and soluble iron (*F. Chever, G. Sarthou, E. Bucciarelli*)

Subroject 3: redox cycle of iron (*G. Sarthou*)

Subproject 4: organic speciation of dissolved iron and humic substances (*S. van den Berg*)

About 170 samples have been collected for dissolved iron analyses, its organic complexation, and humic substances determinations in low density polyethylene bottles (cleaned by J. Bown and M. Boye) and stored at -20°C. The samples will be analysed in Liverpool University (U.K.) in the group of S. van den Berg by the use of voltammetry and FIA-chemiluminescence methods.

Subproject 5: dissolved zinc, cobalt, cadmium distribution and organic speciation in the Southern Ocean (*J. Bown, M. Boye*)

Subproject 6: dissolved copper and/or manganese distribution and complexation (*M. Boye*)

Copper and manganese are essential micro-nutrients. Furthermore it was realized that Cu may act in reductive dissociation of Fe-organic complexes at the cell surface, hence facilitates iron uptake and phytoplankton growth. Additionally the external sources of trace metals into the oceans are either from the atmosphere (dust) or sediments, where Mn can be used as a tracer of the sedimentary iron redox cycling source. About 170 samples have been collected for dissolved copper and/or manganese analyses, the organic complexation in low density polyethylene bottles (cleaned by J. Bown and M. Boye) and stored at -20°C. The samples will be analysed at LEMAR (IUEM, FR) in the group of M. Boye by the use of voltammetry method.

Subproject 7: dissolved and particulate iron isotopic composition (*F. Lacan, A. Radic*)

Subproject 8: distribution of the dissolved cadmium isotopic composition (*G. Henderson, S. Ripperger*)

About 8 depths per SUPER station have been sampled by M. Boye for dissolved cadmium isotopic composition (e.g., about 40 samples in total) in low density polyethylene bottles of

1 to 10 L, and stored at room temperature. The samples will be analysed for their isotopic composition in cadmium by mass spectrometry in Oxford University (U.K.) in the group of G. Henderson by S. Ripperger.

Subproject 9: dissolved and particulate aluminium analytical comparison (*P. Croot, B. Wake, M. Boye*)

Aluminium can be used as an atmospheric source tracer for several trace metals, such as iron. However for this element there have been reports of contamination during storage due to release of Al from the plastic of the storage bottles. Here we have collected duplicates samples for both particulate and dissolved Al analyses stored at pH 1.8 (nitric acid) at room temperature in low-density polyethylene bottles and in PMP bottles (cleaned by J. Bown) that will be analysed by ICPMS at NOCS (UK) by B. Wake and compared with a modified method of FIA-Chemiluminescence at IFM-GEOMAR (GR) in the group of P. Croot.

Subproject 10: dissolved trace metals analytical comparison (*M. Boye, B. Wake, J. Bown, R. Losno, F. Chever, S. van den Berg, F. Lacan, G. Henderson, S. Ripperger*)

Duplicates samples for dissolved trace metals analyses stored in low-density polyethylene bottles at pH 1.8 (nitric acid) at room temperature will be analysed by ICPMS at NOCS (UK) by B. Wake, by voltammetry for Zn, Co, Cd by J. Bown at LEMAR (IUEM, FR); and compared with analyses of samples stored at pH 1.8 (HCl) in Teflon vials by ICPAES at LISA (FR) in the group of R. Losno.

The dissolved iron concentrations (< 0.2 microm; expect for F. Lacan: < 0.4 microm) that will be determined by ICPMS (B. Wake; F. Lacan), FIA-Chemiluminescence (F. Chever; S. van den Berg) and ICPAES (R. Losno) will be compared in order to draw an intracomparison of the methods and procedures for dissolved iron.

The dissolved cadmium concentrations (< 0.2 microm) that will be determined by ICPMS (S. Ripperger), and voltammetry (J. Bown) will be compared in order to draw an intracomparison of the methods for dissolved cadmium.

Subproject 11: co-impacts of zinc, iron, cobalt on the phytoplankton (*B. Wake, M. Boye, J. Bown*)

Subproject 12: co-impacts of iron and copper on the phytoplankton (*G. Sarthou, E. Bucciarelli, F. Chever*)

Subproject 13: impact of iron on the nitrogen uptake rate (*P. Monteiro, W. Joubert, S. Thomalla, H. Waldron, B. Wake, M. Boye*)

Subproject 14: hydrogen peroxide (*E. Bucciarelli)*

2.2. Trace metals (zinc, cobalt, cadmium) cycles during the BONUS-GOODHOPE cruise

Johann BOWN (johann.bown@univ-brest.fr)
Marie Boye (marie.boye@univ-brest.fr)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Scientific objectives

First one is to study the distributions of the micro-nutrients cobalt (Co), zinc (Zn) and cadmium (Cd) in the Southern Ocean by mean of analysis of their organic speciation and dissolved concentrations in the water column. The second objective is to further understand their biogeochemical cycles in the atlantic sector of the Southern Ocean, and their roles in the (co-)limitations of the phytoplankton growth in this region, hence on the biological pump of carbon.

Protocoles

The samples were collected with Go-Flo bottles attached to a Kevlar line and closed using by Teflon messengers, on every Super and Large stations with extra samples collected for the Intercalibration exercice as part of the GEOTRACES objectives. Seven LARGE stations of 10 depths (0-2000 m) and five SUPER stations of 20 depths (0-4000 m) were sampled, given about 170 samples per metal and per analysis.
The samples are filtered on 0.22 µm Sartorius filter under pure N_2 pressure, and collected in LDPE clean bottles (500 ml*2 for organic speciation, 250 ml for dissolved concentrations).
Organic speciation samples are stored in doubled bag and frozen at -20°C. Dissolved concentration samples are acidified with Ultrapur Acid (at pH=1.8) and stored at ambient temperature.

Method

The organic speciation and dissolved concentrations will be determined by Voltammetry at LEMAR.

References

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J.R. Donat and K.W. Bruland (1998). Direct Determination of Dissolved Cobalt and Nickel in Seawater by Differential Pulse Cathodic Stripping Voltammetry Preceded by Adsorptive Collection of Cyclohexane-1,2=dione Dioxime Complexes. *Anal. Chem.*, 60, 240-244.

2.3. Trace metal distributions in the BONUS-GOODHOPE transect

Bronwyn Wake (bronwyn.wake@gmail.com)
Marie Boye (marie.boye@univ-brest.fr)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Eric Achterberg (eric@sea.noc.soton.ac.uk, not onboard)
School of Ocean & Earth Science
National Oceanography Centre Southampton
University of Southampton
UK- Southampton SO14 3ZH

The concentration of a number of trace metals will be determined for the BONUS-GOODHOPE transect. Samples were collected, by Go-Flo bottles on a Kevlar cable, at the 7 Large Stations (normally at 10 depths) and at the 5 Super Stations (normally 16-20 depths). Samples were collected for dissolved (0.2 μm filtered) and total metals (unfiltered), with both being preserved with nitric acid, stored at ambient temperature. Analysis will be done by isotope dilution-inductively coupled plasma mass spectrometry (ID-ICPMS), which allows the preconcentration of the sample and removal of the matrix at the NOCS (U.K.) in collaboration with E. Achterberg.

There have been very few studies investigating this range of trace metals in the oceans. This work will add to the GEOTRACES project, in providing a more comprehensive global database of trace metal concentrations in the various water masses of the ocean.

2.4. Dissolved, total dissolvable and soluble iron concentrations in the water column along the Bonus-Goodhope transect

Fanny Chever (fanny.chever@univ-brest.fr)
Géraldine Sarthou (geraldine.sarthou@univ-brest.fr)
Eva Bucciarelli (eva.bucciarelli@univ-brest.fr)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Scientific objectives

The role of iron in limiting primary production and in partly controlling the structure of the planktonic community in the Southern Ocean is now well established. However, the fraction available for the phytoplankton is still unknown. The main objective is here to study the different physical (total dissolvable TDFe, dissolved DFe and soluble FeS) and redox (Fe(III) and Fe(II) (see cruise report from Sarthou *et al.*) fractions of iron in seawater to better understand this topic.

Scientific and sampling strategies

Depth profiles of dissolved, total dissolvable and soluble Fe were sampled at all stations where Go-Flo casts were performed, ie the seven large stations (0-2000 m) and the five super stations (0-4000 m max).

Sampling and method

Ten Go-Flo bottles hanged on a Kevlar line were used to take samples from the surface to the bottom. Sub sampling of the Go-Flo bottles were performed in a clean container. Go-Flo bottles were gently pressured with N_2 (high purity grade) allowing on line filtration of seawater through 0.2 µm cartridges (SARTOBAN). Soluble samples were obtained by filtration of dissolved samples on 0.02 µm filters (ANOTOP 25). The samples were stored in trace metal clean 60 ml HPDE bottles and acidified by ultrapure HCl at pH 2 (as duplicates for DFe and TDFe).

The samples were stored for at least 24 h before analysis. Five profiles of DFe were determined on board using a Flow Injection Method with chemiluminescence detection, adapted from Obata *et al.* (1993). The purification of the solution of luminol through an 8-hydroxyquinoline resin column improved both the blank and detection limit of the method. The blank was determined every day. It was equal to the mean of 5 measurements of a low iron concentration sample with 0 s of preconcentration (extrapolation from the signals resulting from 10s and 120s of preconcentration). Blanks varied between 9 to 36 pM with a mean value of 23 ± 10 pM (n=8). The detection limit, equal to three times the standard deviation of the blank, ranged from 2 to 22 pM with an average value of 9 ± 6 pM (n=8). The individual contributions to the total blank of hydrochloric acid, ammonia, and ammonium acetate buffer were determined by addition of increasing amounts of these reagents in the sample and were lower than our detection limit.

Preliminary results

The figure 4 below shows five profiles of DFe samples analysed on board and displays no obvious contamination. For these profiles, DFe concentrations in surface waters were lower than 0.5 nM. Concentrations increased with depth up to 1.0 nM near the bottom (station S1). These profiles are typical of the open ocean.

At the laboratory, DFe profiles will be completed and duplicate samples will be analysed in order to validate our data. Total dissolvable and soluble samples will also be analysed. These data will be discussed taking into account physical and other biogeochemical parameters (water masses, nutrients, other tracers).

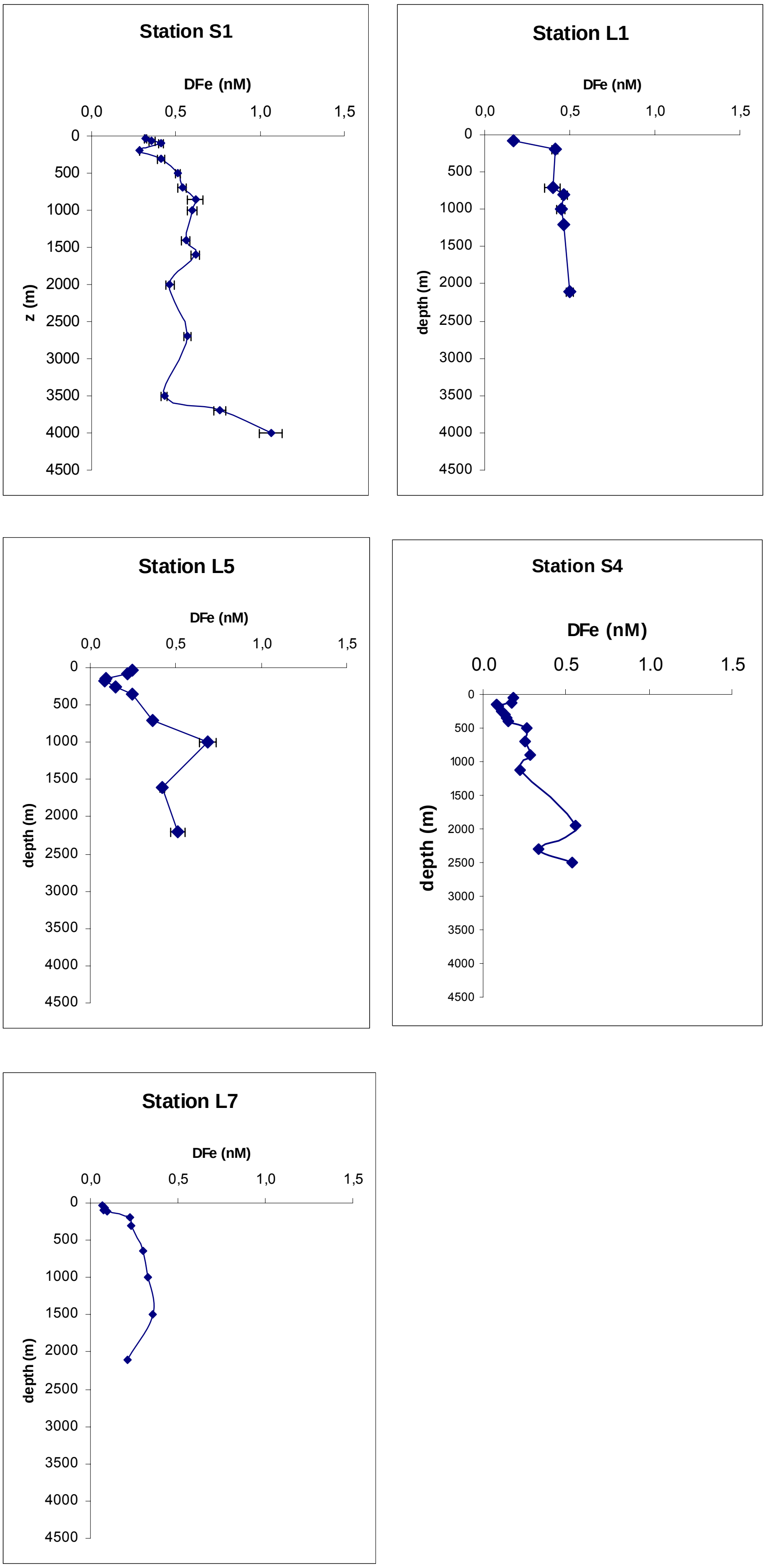

Figure 4- Distribution of dissolved iron concentrations at 5 stations

2.5. Fe(II) concentrations in the water column along the Bonus-Goodhope transect

Géraldine Sarthou (geraldine.sarthou@univ-brest.fr)
Eva Bucciarelli (eva.bucciarelli@univ-brest.fr)
Fanny Chever (fanny.chever@univ-brest.fr)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Scientific Objectives

The role of iron in limiting primary production in the oceans is now well established (Blain *et al.*, 2007; Boyd *et al.*, 2007). In oxic waters, Fe(III) is the dominant redox species, but is highly insoluble. Although Fe(II) is more soluble than Fe(III), it is rapidly oxidised by oxygen and hydrogen peroxide (Millero *et al.*, 1987). However, in the Southern Ocean, Fe(II) has been shown to exist for several hours and at elevated concentrations (<1 nM) (Croot *et al.*, 2001). The reduction of Fe(III) to Fe(II), with subsequent re-oxidation to Fe(III) is a possible mechanism by which colloidal iron is made more bioavailable to phytoplankton (Croot *et al.*, 2001).

The objectives of this works were to examine the redox state of iron along a north-south latitudinal transect in order to better understand the redox cycle of Fe(II).

Sampling and method

Depth profiles of Fe(II) were performed at the seven large stations (0-2000 m) and five super stations (0-bottom). Fe(II) concentrations were also measured in samples from on-board incubations (see cruise report for on-board Fe-Cu incubations). All samples were collected and processed using trace-metal clean techniques. For depth profiles, samples were collected using acid-cleaned Go-Flo bottles mounted on a 6 mm Kevlar hydrowire. The bottles were individually attached to the synthetic line and triggered at depth using Teflon messengers. Fe(II) samples were processed immediately. Sub sampling of the Go Flo bottles (60 ml) were performed in a clean container and the maximum time between sample collection and analysis was 5 min. Total (unfiltered samples) Fe(II) were collected at each station. Dissolved Fe(II) (< 0.2 µm) were also collected at Go-Flo 1 and 2.

Concentrations of Fe(II) were determined on board using a Flow Injection Method with chemiluminescence detection (Croot , Laan, 2002; Hopkison , Barbeau, 2007). The typical detection limit was 10±7 pM.

Preliminary results

Figure 5 shows depth profiles of filtered (Fe(II)d) and total Fe(II) samples ((Fe(II)t). Except at the shallowest and deepest depths (5.1% and 3.7%, respectively), dissolved Fe(II) represented less than 3% of total Fe(II) and were close to or lower than the detection limit.

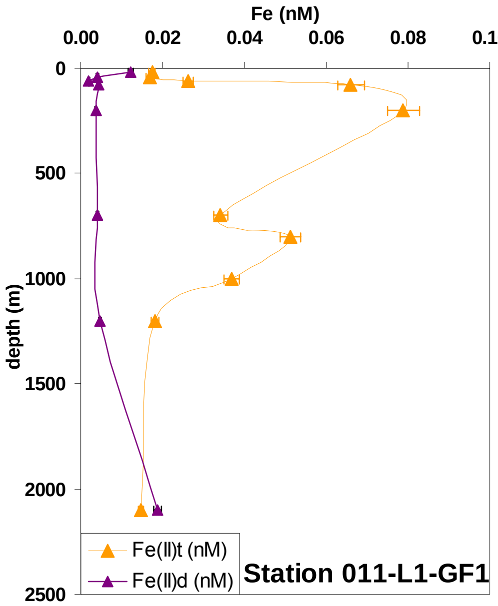

Figure 5- Depth profiles of total and dissolved Fe(II) at station L1

On Figure 6, we reported depth profiles of Fe(II)t and dissolved Fe (see cruise report from Chever *et al.*) at stations L1 and S1 (Go-Flo # 1 and 2). Fe(II)t varied between 3 and 40% of DFe at station L1 and between 2 and 8 % of DFe at station S1.

Back in the laboratory, Fe(II) data will be processed for the other profiles and the Fe on-board incubations. Data will be delivered to the data base within the next 6 months.

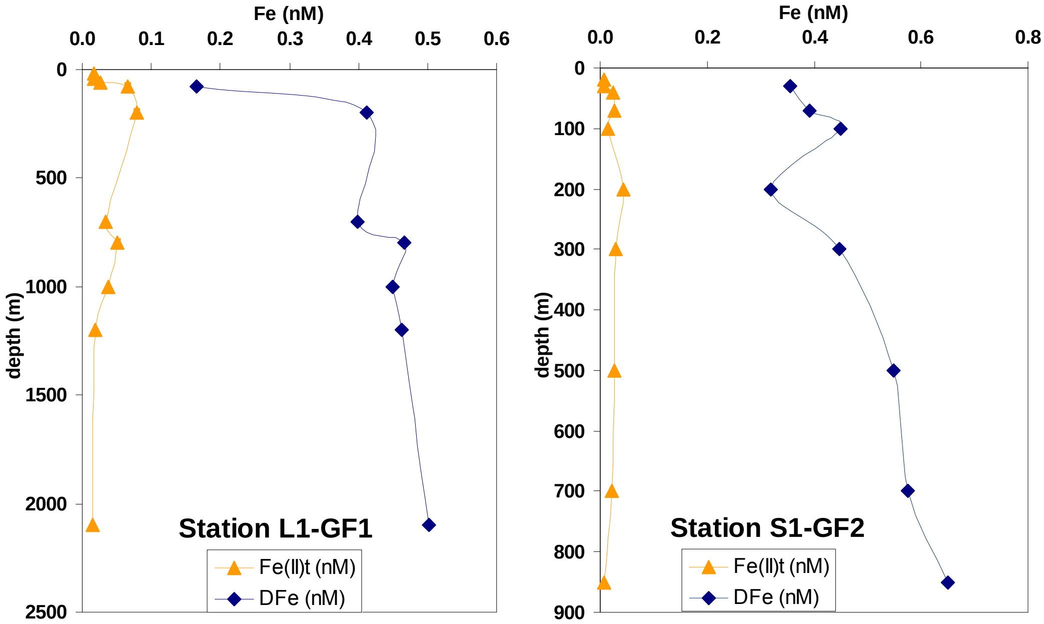

Figure 6- depth profiles of Fe(II)t and DFe (see cruise report Chever et al.) at station L1 and S1.

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2.6. Iron isotopic composition

François Lacan (lacan@legos.obs-mip.fr)
Laboratoire d'Etude en Géophysique et Océanographie Spatiales
14 av. E. Belin
FR- 31400 Toulouse

Scientific objectives

Iron isotopic composition (Fe IC) and concentration, in the dissolved (<0.4 micrometer) and particulate phase will allow to quantify and estimate, notably :

- Matter exchange fluxes between the lithosphere and the ocean
- Dissolved particulate interactions
- Origin of the iron (Aeolian, sediment). Isotopic fractionation factors involved in Fe oceanic cycle. Fe dissolved particulate interactions.

Scientific and sampling strategies

Dissolved and particulate Fe IC: 50 samples

Protocols

Parameter definitions:

Fe IC: Iron isotopic composition

Sampling, storage and analysis procedures:

Fe IC: Goflo sampling. 10 L per sample (20 for the two shallowest of each station). Filtration at 0.4 micrometer. Storage at pH=2 (HCl). Analyses with ICPMS, TIMS, MC-ICPMS. Filters stored at -20ºC.

Preliminary results

None.

Data delivery

Within 2 to 4 years from now.

2.7. Co-impacts of trace metals (Fe, Zn, Co) on phytoplankton assemblage, growth and biological processes.

Bronwyn Wake (bronwyn.wake@gmail.com)
Marie Boye (marie.boye@univ-brest.fr)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Motivation

The growth of various phytoplankton species has been shown, in laboratory monoculture experiments, to be limited by various metals, these include iron, zinc and cobalt. This can be a direct limitation or a co-limitation. It has also been shown that some species are able to substitute one metal for another under deplete conditions to meet a requirement.

This work will investigate the different phytoplankton assemblages of the Southern Ocean regions and if limitation by trace metals is occurring. Field experiments (both *in situ* and bottle experiments) have shown iron addition to cause an increase in growth and cell health. Other metals have not shown as clear a response from the limited field studies done.

Method

Water was collected in the fluorescence maximum using Go-Flo bottles (trace metal clean Kevlar cable deployed). The water was processed under trace metal clean conditions. It was prescreened (200 µm) and mixed in 30 L tanks to ensure homogeneity. For incubations 1-3, 48 polycarbonate bottles (2.4 L) were used and the experiments ran for 8 days; incubation 4 was 44 polycarbonate bottles for the duration of 10 days.

Treatments for each incubation are detailed below, all metal additions were at 2 nmol l^{-1}, incubation 1 and 2 had nitrate and phosphate added to all treatments including the control.

Incubation 1	Incubation 2	Incubation 3	Incubation 4
Control	Control	Control	Control
+Zn	+Zn	+Zn	+Zn
+Co	+Co	+Co	+Co
+Fe	+Cd	+Fe	+Fe
+Zn+Co	+Zn+Co	+Zn+Co	+Zn+Co
+Zn+Fe	+Co+Cd	+Zn+Fe	+Zn+Fe

The bottles were placed in incubations, screened with neutral density screens to 50% light. The temperature in the incubations was control to ensure it remained the same as the sample collection temperature.

The number of bottles allowed for each treatment to be run in duplicate with 4 sampling points. At each of these sampling points, a bottle from each treatment was taken and completely sampled. Samples were collected for dissolved metals, nutrients (N, P and Si), flow cytometry, POC/PON/PIC and chlorophyll *a* and pigment analysis.

2.8. On-board Fe-Cu incubations

Géraldine Sarthou (geraldine.sarthou@univ-brest.fr)
Eva Bucciarelli (eva.bucciarelli@univ-brest.fr)
Fanny Chever (fanny.chever@univ-brest.fr)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Scientific Objectives

The limiting role of trace metals and particularly iron (Fe) in controlling phytoplanktonic production and the structure of the planktonic community is now largely admitted in the Southern Ocean (Martin *et al.* 1990, Boyd *et al.* 2000). Fe is indeed involved in many essential cellular processes like photosynthesis, and subnanomolar concentrations of this metal are often limiting for phytoplankton growth and have a major impact on the major biogeochemical cycles (C, N, Si, S) (Watson *et al.* 2000, Turner *et al.* 2004). However, the bioavailable form of iron has still to be determined (soluble, dissolved, Fe(III), Fe(II), organic iron…). Besides, other trace metals may act as co-limiting factors. A recent study showed the role of copper (Cu) in increasing the Fe stimulation of phytoplankton growth in the Subarctic Pacific, another Fe-limited region (Cochlan *et al*. 2007). In this study, we aimed at better determine the effect of Fe and Fe-Cu additions on the growth parameters of the phytoplanktonic community in on-deck incubations, and the bioavailable form of Fe in these incubations.

Protocols

On-board Fe-Cu incubations were performed at super stations (S1, S2, S3, and S4). Seawater for incubations was collected between 30 and 60 m, using acid-cleaned Go-Flo bottles mounted on a 6 mm Kevlar hydrowire. The bottles were individually attached to the synthetic line and triggered at depth using Teflon messengers. Seawater was gently mixed in acid-cleaned 30-l Nalgene polyethylene carboys, then immediately transferred into acid-cleaned 2.4-l Nalgene polycarbonate bottles after screening through a 200 µm mesh sieve to exclude larger organisms.

The 2.4-l experimental containers were immediately amended with iron and/or copper, macronutrients, pore waters as described below, then capped, sealed with PVC tape, and set in circulating surface seawater inside polyethylene incubators located on deck.

Station	Position, start date	Ambient conditions	Experimental treatments
Super Station 1	36.3 S, 13.07 E 21 Feb. 2008	T = 22°C	Control (untreated) + Fe + nutrients (Si, N, P) + Fe + nutrients + Fe + Cu + nutrients + porewaters
Super Station 2	42.28 S, 08.55 E 27 Feb. 2008	T = 12°C	Control (untreated) + nutrients (Si, N, P) + nutrients + Fe + nutrients + Cu + nutrients + Fe + Cu
Super Station 3	47.33 S, 04.22 E 5 March 2008	T = 8°C	Control (untreated) + nutrients (Si, N, P) + nutrients + Fe + nutrients + Cu + nutrients + Fe + Cu
Super Station 4	51.51 S, 00.00 E 11 March 2008	T = 2°C	Control (untreated) +Cu +Fe +Fe + Cu + 2 Fe

Samples were taken for nitrate, silicate, phosphate, chlorophyll a, POC/PON, biogenic silica, cytometry, taxonomy identification, total Fe, dissolved Fe (< 0.2 µm), soluble Fe (< 0.02 µm), Fe(II), total Cu, organic Fe and Cu, and hydrogen peroxide.

Preliminary results

Most of the parameters will have to be analysed at the laboratory. Chlorophyll and nutrients were analysed on board and data have now to be processed. At first sight, it seemed that Fe additions enhanced chlorophyll levels at all stations, while Cu had different effects depending on the station.

Data delivery

Data validation and processing of nutrients and chlorophyll will take less than 6 months, allowing on time data base delivery. The analyses of the other data should be done in 12-18 months, depending on the parameter.

2.9. New production response to iron addition

Pedro Monteiro (pmonteir@csir.co.za)
Warren Joubert (wjoubert@csir.co.za)
Council for Scientific and Industrial Research, RSA, SA.

Howard Waldron (howard.waldron@uct.ac.za)
Sandy Thomalla (sandy_thomalla@yahoo.com)
University of Cape Town, RSA, SA.

Collaborations with:
Browyn WAKE (bronwyn.wake@gmail.com)
Marie BOYE (marie.boye@univ-brest.fr)
LEMAR- IUEM- Technôpole Brest Iroise- FR-29280 Plouzané.

Nitrate uptake / Iron addition experiments

Three SUPER stations were sampled using GO-FLO bottles for on deck incubations testing the impact of iron on the uptake rate of nitrogen (Annexe 3). These experiments were conducted in waters with both low and high nitrate-N concentrations. It is assumed that the latter environment was a high nutrient, low chlorophyll (HNLC) area and hence iron-limited. Each experiment lasted for a total of 5-6 days. Broadly speaking, the experiment was designed to investigate the phytoplanktonic nitrate uptake response (new production/carbon export) to the addition of iron in a HNLC area. It was necessary to follow trace metal clean protocols during the set-up and execution of this experiment and we were fortunate to have the advice and facilities of colleagues on board (B. Wake and M. Boye). A mixed, bulk sample (36L) was collected in the euphotic zone using Go-Flo bottles on a Kevlar cable, sampled in a clean container and divided into thirty six, 1L sub-samples. The sub-samples were pre-screened (200 μm) and poured into acid-cleaned polycarbonate bottles. Eighteen of these bottles were spiked with $^{15}NO_3$-N at <10% of the ambient NO_3-N concentration. The remaining 18 bottles were similarly treated and, in addition, 2 nano-moles of Fe were added. The 36 bottles were then incubated at a simulated 50% light level. This made it possible to run a 6 day experiment with 3 controls ($^{15}NO_3$-N only) and 3 iron-enriched ($^{15}NO_3$-N + Fe) sub-samples being removed each day (T1, T2, T3, T4, T5 and T6). It is hoped that this will give a time-series of nitrate uptake response. After removal from the incubator, a 100ml sub-sample was removed from one control and one iron-enriched bottle for iron-contamination tests and 1ml was removed for flow-cytometry analysis to determine the response of the phytoplankton assemblage during the 6 day experiment. Note that this was also done on To samples prior to the commencement of the experiment. Initial nitrate-N concentration was determined as described previously. The trace metals concentrations in the incubations, especially iron, will be determined by B. Wake. Other sampling parameters will be analysed in the group of P. Monteiro.

2.10. Trace metals (and nutrients) in aerosol and rain

Alex Baker (alex.baker@uea.ac.uk; not onboard)
School of Environmental Sciences
Norwich, NR4 7TJ, UK

Sampling on board :
Elisabet Verdeny (Person in charge, elisabet.verdeny@uab.es)
Núria Casacuberta (elisabet.casacuberta@uab.es)
José Luis Amado (joseluis.amado@uab.es)
Universitat Autonoma de Barcelona
Bellaterra, Spain

Scientific motivation

Atmospheric transport is the dominant means by which iron is supplied to the remote ocean. This is particularly important in the SO, an area removed from the world's major deserts and where surface water iron concentrations are extremely low. Aerosol iron percentage solubility is generally low at high dust loadings, but systematically increases as dust concentrations decrease (Baker & Jickells, 2006). Furthermore over most of the Atlantic Ocean, soluble aerosol iron is in excess, relative to the other nutrients, in terms of phytoplankton nutrient requirements (Baker *et al.*, 2003). To date the solubility of aerosol iron over the remote SO has not been determined, nor have the concentrations of the other major nutrients (N, P, Si) or micronutrient trace metals (e.g. Zn, Co, Cd) in that aerosol been determined.

Sampling methodology

Continuous sampling for aerosols was done using a high-volume (1 m^3 min^{-1}) sampler equipped with a bulk aerosol sampling head (Whatman 41 filter). Aerosol filters had been triple-washed with HCl to reduce trace metal contamination. Rain samples were collected very sporadically on an event basis by deploying large (40 cm diameter) plastic funnels for the duration of rainfall only. These samples were collected in pairs for trace metal analysis (using equipment washed with HNO_3) and major ion analysis (using equipment washed with ultrapure water).

Samples for aerosols in filters and rain/snow in pre-cleaned bottles were stored frozen from just after collection. Samples will also be transported frozen (at -20ºC) to the home lab at University of East Anglia (UEA, UK) for further analysis.

Various extraction methods will be used for aerosol analysis, followed by detection using ion chromatography, ICP-OES and other methods. Rain samples will be analysed using equivalent procedures. All analysis will be in the home laboratory (UEA, UK).

Sampling results

A total of 8 aerosol samples were collected, pumping between 1.5 and 3.5 days each, in a continuous sampling. Procedural blanks (cassette blank, motor blank and exposure blank) were run towards the end of the cruise during passage to South Africa.

A total of 3 rain samples were collected, for both Major Ions and Trace Metals, and a blank was run for every sample.

Start Locations for aerosol samples collected during BONUS-GOODHOPE cruise.

Sample	Start Time & Date	Start Location
BG08M 01	13/Feb/2008 15:30	33º 59 S, 18º 00 E
BG08M 02	14/Feb/2008 16:40	34º 00 S, 16º 52 E
BG08M 03	16/Feb/2008 13:55	34º 06 S, 15º 10 E
BG08M 04	22/Feb/2008 06:50	36º 35 S, 13º 03 E
BG08M 05	25/Feb/2008 12:30	40º 43 S, 10º 13 E
BG08M 06	29/Feb/2008 10:16	44º 02 S, 7º 38 E
BG08M 07	06/Mar/2008 20:00	48º 19 S, 3º 35.06 E
BG08M 08	12/Mar/2008 14:00	53º 00 S, 0º 0.38 W

Start Locations for rain samples collected during BONUS-GOODHOPE cruise.

Sample	Start Time & Date	Start Location
BG08RI 01	27/Feb/2008 06:00	42º 28 S, 8º 56 E
BG08RI 02	15/Mar/2008 21:30	57º 33 S, 0º 02 W
BG08RI 03	17/Mar/2008 11:00	57º 33 S, 0º 03 W

2.11. Hydrogen peroxide

Eva Bucciarelli (eva.bucciarelli@univ-brest.fr)
Géraldine Sarthou (geraldine.sarthou@univ-brest.fr)
Fanny Chever (fanny.chever@univ-brest.fr)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Scientific objectives

Hydrogen peroxide (H_2O_2) is one of the most powerful oxidant in marine waters, and it is also a strong reductant (H_2O_2 / H_2O - O_2 / H_2O_2). Amongst reactive oxygen species (ROS), it is the most abundant (concentrations can be up to 300nM) and its life time is the longest (Asada et Takahashi., 1987, Mopper et Kieber., 2000). Because of its high reactivity, it affects the marine cycles of many organic compounds and the redox state of trace metals. It partly controls the speciation of Fe between its two redox species Fe(II) and Fe(III) (Moffett, 2001, Bagheri *et al*., 2000). Iron is an essential micronutrient for phytoplankton, but the chemical form available to phytoplankton is still unknown. The Southern Ocean is known to be an Fe limited area, which impairs the ability of phytoplankton to grow at its maximum. In the context of the study of the marine biogeochemical cycle of this essential micronutrient, and in parallel to the study of Fe (see Chever *et al.* and Sarthou *et al.* in this report), we investigated the distributions of H_2O_2 in order to better understand how this molecule affects the redox speciation of this trace metal.

Scientific and sampling strategy

All samplings were done at the same time as Fe samplings, ie large A, large B and super stations.

Material and methods

Ten Go-Flo bottles hanged on a 4000m Kevlar line were used to take samples from the surface to the bottom. Seventeen casts were realised. Sub sampling of the Go Flo bottles were performed in a clean container. Go-Flo bottles were gently pressured with N2 (high purity grade) allowing on line filtration of seawater through 0.2 µm cartridges (SARTOBAN). Dissolved and total samples for H2O2 analyses were collected in 60 ml bottles. All samples were analysed on board in 3 hours after collection using a flow injection method with chemiluminescent detection (Yuan and Shiller, 1999).

Preliminary results

Most of the data still have to be processed. On a general basis however, it was seen that vertical distributions of H_2O_2 exhibited high concentrations in the surface layers (up to ~80 nM), decreasing rapidly with depth (generally inferior to a few nanomolar below 200 m). An interesting feature was the lower concentrations of dissolved than of total H_2O_2 observed during daylight samplings at the northernmost stations in the surface layers (Fig. 7).

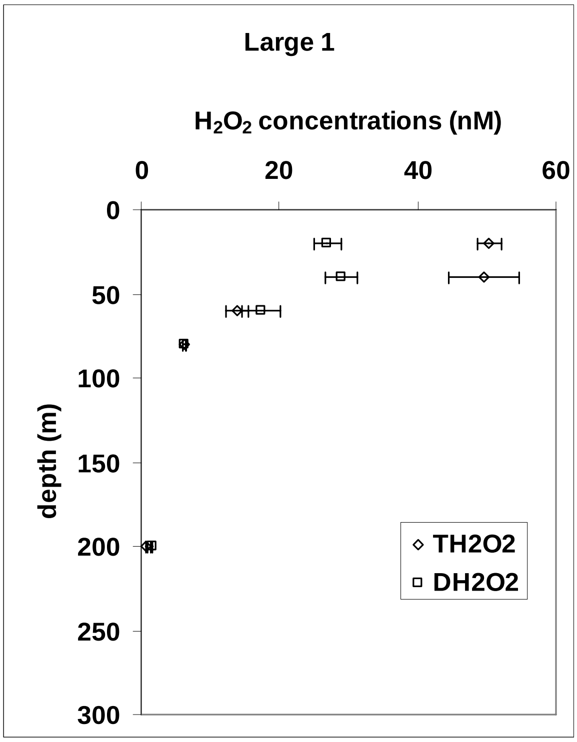

Figure 7- Vertical distributions of total and dissolved H2O2 concentrations (nM) at station L1 versus depth (m).

This feature is not explained at the moment, but might involve H_2O_2 production by phytoplankton during photosynthesis.

Data delivery

Analyses were already performed onboard. Data validation and processing should take less than 6 months, allowing on time data base delivery.

3. ORIGIN, PATHWAYS, and VENTILATION OF THE WATER-MASSES

3.1. Neodymium isotopic composition, ^{230}Thorium, ^{231}Protactinium, Rare Earth Elements

François Lacan (lacan@legos.obs-mip.fr)
Catherine Jeandel (jeandel@legos-obs-mip.fr; not on board)
Laboratoire d'Etude en Géophysique et Océanographie Spatiales
14 av. E. Belin
FR- 31400 Toulouse

Matthieu Roy-Barman (matthieu.roy-barman@lsce.cnrs-gif.fr; not on board)
LSCE-Vallée
Bat. 12,
Av. de La Terrasse
FR-91198 Gif-Sur-Yvette Cedex

Scientific objectives.

Neodymium isotopic composition (Nd IC), ^{230}Th and ^{231}Pa concentrations, Rare Earth Element concentrations (REE) in the dissolved (<0.4 micrometer) and particulate phase will allow to quantify and estimate, notably :

- Vertical particulate fluxes, particle settling velocities (^{230}Th and ^{231}Pa)
- Transit times of water masses involved in vertical motion (convection, subduction, upwelling… ^{230}Th and ^{231}Pa)
- Origin and mixing of water masses (Nd IC, REE)
- Matter exchange fluxes between the lithosphere and the ocean (Nd IC, REE)
- Dissolved particulate interactions (^{230}Th and ^{231}Pa, Nd IC, REE)
- Origin of the iron (Aeolian, sediment). Isotopic fractionation factors involved in Fe oceanic cycle. Fe dissolved particulate interactions. (Nd IC, Fe IC).

Scientific and sampling strategies

Sampling at the super stations (5 stations).
Dissolved ^{230}Th, ^{231}Pa, Nd IC, REE : 61 samples
Particulate ^{230}Th, ^{231}Pa, Nd IC, REE (in situ pumps): 36 samples

Protocols

Parameter definitions:
^{230}Th : concentration of ^{230}Th per seawater mass unit.
^{231}Pa : concentration of ^{231} per seawater mass unit.
Nd IC: neodymium isotopic composition
REE: Rare Earth Element concentrations per seawater mass unit.

Sampling, storage and analysis procedures:

^{230}Th and ^{231}Pa, Nd IC, REE :

- Dissolved phase: sampling with Niskin bottles, 20 L per sample, filtration at 0.4 micrometer, onboard preconcentration. Storage at pH=2 (HCl). Analyses with ICPMS, TIMS, MC-ICPMS.
- Particulate phase : sampling with in situ pumps, 0,4 micrometer. Analyses with ICPMS, TIMS, MC-ICPMS. Storage at -20ºC.

Preliminary results

None.

Data delivery

Within 2 to 4 years from now.

3.2. ^{226}Radium, ^{228}Radium and ^{227}Actinium

^{226}Ra and ^{228}Ra
Claudia Hanfland (chanfland@awi-bremerhaven.de; not onboard)
Alfred Wegner Institute, AWI, Germany

^{227}Ac
Walter Geibert (wgeibert@staffmail.ed.ac.uk; not onboard)
University of Edinburgh, UK)

Sampling on board :
Elisabet Verdeny (Person in charge, elisabet.verdeny@uab.es)
Núria Casacuberta (elisabet.casacuberta@uab.es)
José Luis Amado (joseluis.amado@uab.es)
Universitat Autonoma de Barcelona
Bellaterra, Spain

Scientific motivation

The two long-lived Radium isotopes ^{226}Ra and ^{228}Ra show a contrasting pattern in subpolar and subantarctic waters (Hanfland 2002): ^{226}Ra ($T_{1/2}$ = 1600 yrs) is known to increase steadily in the surface waters from North to South across the ACC (Chung 1974; Hanfland 2002; Jacquet et al., 2004) due to replenishment from upwelling of nutrient-rich waters. In contrast, ^{228}Ra ($T_{1/2}$ = 5.8 yrs) accumulates to high activities in shallow water bodies overlying continental shelf areas. It can hence be used as a tracer of shelf water input and helps to identify advection of shelf waters into the open ocean (Moore 1969, Li et al. 1980). ^{227}Ac is also a useful tracer for water mass circulation, upwelling, and mixing rates (Nozaki, 1984; Geibert *et al.*, 2002). The combined analyses of ^{227}Ac and ^{228}Ra can also be used to distinguish between vertical versus lateral movement of water masses. In the region of interest, the Agulhas Current is particularly prone to collect a distinctive shelf ^{228}Ra signal during its southward flow along the continental shelf edge of South Africa. By contrast, waters protruding northward from the Antarctic Zone generally lack clear ^{228}Ra signals as they have not been in contact with shelf sediments for a relatively long time.

Sampling methodology and sampling treatment on board

^{226}Ra, ^{228}Ra and ^{227}Ac were collected using MnO_2-coated filter cartridges (1 µm) via in-situ pumping filtration, using battery operated pumps that filter large volumes of water (100-1000 L). Filter cartridges were sealed wet in plastic bags to be transferred to the AWI lab for further analysis. Analysis in the home-lab will allow determining the activity ratio ^{228}Ra/^{226}Ra and the absolute ^{227}Ac activities. Besides, absolute activities of ^{228}Ra and ^{226}Ra can be obtained if the absolute ^{226}Ra activity is known. Therefore, parallel samples of ~ 24 L seawater, obtained from regular CTD casts using Niskin bottles, were taken specifically for ^{226}Ra. A quantitative precipitation with $BaCl_2$ led to the formation of $Ba(Ra)SO_4$,thereby concentrating the Radium activity in a small sample volume. The precipitate was then transferred to 250 mL LDPP bottles for an easy transport to the home-lab. The procedural recovery can calculated via the Ba content.

The Ba precipitates will be measured by gamma-spectrometry detection at home-lab (AWI, Germany). The MnO_2-coated cartridges will be radiochemicaly treated at AWI. A leaching procedure followed by iron precipitation and ion column chemistry will allow separating the different isotope fractions. ^{227}Ac will be determined by alpha-spectrometry. Analysis of the ^{228}Ra/^{226}Ra activity ratio will be done either by direct gamma-counting of the precipitated leachate or further processing following the so-called ^{228}Th-ingrowth method.

Sampling results

Water column profiles (surface-bottom) of 3-4 successful depths for ^{228}Ra/^{226}Ra and 2 depths for ^{227}Ac were collected using MnO_2-coated cartridges with the in-situ pump deployments. An additional cartridge sample for ^{228}Ra/^{226}Ra was obtained by filtering 1000-1500 L of surface seawater form the ship's intake supply. An additional sample for ^{227}Ac form the surface was obtained using an alternative sampling method, which involves 100 L of seawater sample, and a MnO_2 co-precipitation. An internal yield of ^{230}Th was used to assess recovery. The precipitate was filtered through 1 µm QMA filters (124 mm diameter) using a peristaltic pump. Two QMA filters were needed for each sample, due to the easy clogging of the filters by the fine MnO_2 precipitate.

Therefore, 4-5 depths cartridge profiles for ^{228}Ra/^{226}Ra were collected at Super Stations 1, 2, 3 and 5. And 3 depths profiles for ^{227}Ac were collected at Super Stations 2, 3 and 5. A total of 19 cartridges will be treated back to home-lab for determining the isotopic activities. A total of 4 cartridges were deployed with unsuccessful pumping (pump did not work).
Seawater samples for ^{226}Ra, necessary to assess absolute ^{228}Ra activities, were also collected at Super Stations 1, 2, 3 and 5, from 3 different depths chosen to match with the in-situ pump sampling depths. An additional ^{226}Ra profile was sampled at the Inter-calibration station. A total of 18 samples were collected, including one replicate.

Compilation of samples collected for ^{226}Ra, ^{228}Ra and ^{227}Ac

Station	Type of	Date			Type of sample			
name	Station	of sampling	Lat (S)	Lon (E)	Ra-226 ppt	Ra-226/228 cartridge	Ac-227 ppt	Ac-227 cartridge
Sta. 18	SUPER 1	21/Feb/2008	36.29.755	13.06.997	3	4		
Sta. 34	SUPER 2	27/Feb/2008	42.28.297	08.56.004	4	5	1	2
Sta. 41	Large B 1	02/Mar/2008	44.53.770	06.53.110	1			
Sta. 48	SUPER 3	05/Mar/2008	47.33.290	04.22.540	3	5	1	2
Sta. 52	Large B 2	07/Mar/2008	49.01.678	02.49.874				
Sta. 62	SUPER 4	11/Mar/2008	51.52.158	- 00.00.109				
Sta. 65	Intercal.	12/Mar/2008	52.58.913	00.00.020	4			
Sta. 72	Large B 3	14/Mar/2008	55.13.948	00.02.611				
Sta. 78	SUPER 5	16/Mar/2008	57.33.150	- 00.02.270	3	5	1	2
				TOTAL	18	19	3	6

3.3. Dissolved barium

Frank Dehairs (fdehairs@vub.ac.be)
Vrije Universiteit Brussel
Laboratory for Analytical & Environmental Chemistry
Pleinlaan 2
B-1050 Brussels
Belgium

Damien Cardinal (damien.cardinal@africamuseum.be)
Royal Museum for Central Africa
Dpt. of Geology and Mineralogy
Section of Mineralogy and Petrography
Leuvensesteenweg, 13
B- 3080 Tervuren
Belgium

Dissolved Ba behaves as a bio-intermediate nutrient (*sensu* Broecker & Peng) showing slight utilization in surface waters and release in the deep waters. While Ba is clearly biogeochemically active, diss. Ba appears to have a pronounced conservative behaviour which makes it a useful tracer of water masses. This strong conservative character is due in part to the fact that concentrations of dissolved Ba (diss Ba) are two to three orders larger than those of particulate Ba (nmol/l vs. pmol/l, respectively; see also below). Diss. Ba correlates well with silicate and alkalinity but the match is never perfect, reflecting the fact that a specific particle-solute interaction exists for this element, in which barite formation and dissolution appears to play a major role.

We sampled for dissolved Ba at all Super and Large stations, and at several Hydro stations (see Table with sample list). A small volume (15 ml) of unfiltered seawater is acidified using ultrapure HCl and saved till later analysis in the home based laboratory. Samples will be diluted 30 times with ultrapure water and spiked with ^{135}Ba. The 135Ba/13Ba ratio is measured using a HR-ICP-MS and mass bias corrected by analyzing natural, unspiked Ba solutions in bracketing mode. The dissolved Ba profiles and resulting transect will be compared with those of silicate, as well as DIC, alkalinity. We will also compare results with diss. Ba results obtained earlier for the Prime Meridian section extending south of the BGH and the Weddell Basin (ANT 23; 2005; collaboration with Mario Hoppema), as well as with diss. Ba sections along 30°E (CIVA-1) and 145°E (SR3).

CTD Rosette casts sampled for dissolved barium

CTD Cast #	station type	station	Date	Long	Lat	depth range
2	Hydro	2	14/02/2008	17.43.220 E	33.56.660 S	0-bottom
4	Hydro	4	14/02/2008	17.18.21 E	33.58.46 S	"
5	Hydro	5	14/02/2008	16.57.13 E	33.59.68 S	"
6	Hydro	6	14/02/2008	16.35.22 E	34.00.74 S	"
7	Hydro	7	15/02/2008	16.12.00 E	34.01.999 S	"
8	Hydro	8	15/02/2008	15.41.20 E	34.03.79 S	"
9	Hydro	9	16/02/2008	15.09.80 E	34.05.50 S	"
10	Hydro	10	16/02/2008	14.35.29 E	34.07.320 S	"
11	Large	11	17/02/2008	14.24.29 E	34.25.67 S	"

13	Hydro	12	17/02/2008	14.13.570 E	34.43.425 S	"
14	Hydro	13	17/02/2008	14.02.780 E	35.01.600 S	"
16	Hydro	15	18/02/2008	13.41.010 E	35.37.510 S	"
17	Hydro	16	18/02/2008	13.29.820 E	35.55.520 S	"
18	Hydro	17	19/02/2008	13.18.590 E	36.13.400 S	"
19	SUPER 1	18	19/02/2008	13.07.320 E	36.31.370 S	"
25	Hydro	20	22/02/2008	12.44.340 E	37.07.040 S	"
30	Hydro	25	24/02/2008	11.34.350 E	38.49.530 S	"
34	Hydro	29	25/02/2008	10.33.010 E	40.17.440 S	"
41	SUPER 2	34	26/02/2008	08.55.700 E	42.28.170 S	"
47	Hydro	36	28/02/2008	08.14.230 E	43.19.460 S	"
53	LARGE 3B	41	1/03/2008	06.53.140 E	44.53.770 S	"
57	LARGE 4A	44	3/03/2008	05.51.890 E	46.01.450 S	"
63	SUPER 3	48	4/03/2008	04.22.610 E	47.33.260 S	"
69	Hydro	51	7/03/2008	03.10.691 E	48.42.078 S	"
70	LARGE 5B	52	7/03/2008	02.49.940 E	49.01.690 S	"
77	LARGE 6A	57	8/03/2008	01.18.130 E	50.22.360 S	"
84	SUPER 4	62	10/03/2008	00.00.041 E	51.51.350 S	"
89	Hydro	64	12/03/2008	00.00.090 E	52.36.080 S	"
94	Hydro	68	13/03/2008	00.00.100 E	53.55.130 S	"
96	Hydro	70	13/03/2008	00.00.042 W	54.34.828 S	"
98	LARGE 7	72	13/03/2008	00.01.380 E	55.13.847 S	"
102	Hydro	74	14/03/2008	00.06.790 E	55.54.260 S	"
106	SUPER 5	78	15/03/2008	00.02.190 W	57.33.150 S	"

3.4. Carbon isotopes (^{14}C and ^{13}C)

Nadine Tisnérat-Laborde (tisnerat@lsce.ipsl.fr)
Martine Paterne (paterne@lsce.ipsl.fr, not onboard)
LSCE/IPSL, CEA-CNRS-UVSQ
Domaine du CNRS
Bat 12
Avenue de la Terrasse
FR-91198 Gif-sur-Yvette

Introduction and scientific objectives

Carbon is one of the most abundant elements in the universe and is the basis for the existence of life on Earth. Knowledge of the cycling of carbon in the ocean is important not only for the understanding of the biogeochemistry of a variety of elements, but also for the global carbon cycle and thus climate changes of human concern.
Carbon-14 also called radiocarbon (^{14}C) is continually formed in nature by the interaction of neutrons with nitrogen-14 in the Earth's atmosphere. It is rapidly converted to carbon dioxide by reaction with atmospheric oxygen and mixed and uniformly distributed with the atmospheric carbon dioxide (CO_2) containing stable carbon-12 and carbon-13. Then, the CO_2 is exchanged with biosphere and ocean reservoirs. In the ocean, this distribution is governed by biological processes and carbonate chemistry. Carbon occurs in inorganic and organic pools: dissolved inorganic carbon (DIC), dissolved organic carbon (DOC), particulate organic carbon (POC), and sedimentary organic carbon (SOC). Measurements of radiocarbon and stable carbon isotopes of these different reservoirs provide some interesting insights into the oceanic carbon cycle and oceanic circulation.

The aim of this study is to investigate the variation of radiocarbon and ™^{13}C signatures of the different forms of carbon in the water column and sediment in the inter-frontal region of Southern Ocean in order to contribute to understand: the zonal circulation : radiocarbon in DIC is a tracer of circulation as CFCs which allows to quantify the recent thermocline ventilation, characterize changes in deep and bottom waters in the Agulhas Current, estimate the temporal and lateral oceanic transport as ^{143}Nd/^{144}Nd and calibrate, evaluate ocean models

Methods

Three different forms of carbon samples (DIC, POC, DOC) were collected at the five SUPER stations to also investigate the variability of carbon isotopes signatures in the inter-frontal zone of the Southern Ocean. We added the Large station 7 for DIC samples to obtain a higher spatial resolution. Due to the Octopus problems, only one SUPER station was sampled for SOC.

Dissolved Inorganic Carbon

119 seawater samples were collected.
250 ml of seawater were collected for depth profile (19-20 depths) using Niskin bottles in the five SUPER stations and LARGE station 7. Seawater was poisoned with 1-ml of saturated $HgCl_2$ solution. Then, the borosilicate bottles were sealed on board.

Once back in the lab, the DIC samples will be acidified (phosphoric acid) and stripped of CO_2 by recirculated nitrogen gas (Leboucher *et al,* 1999).

Particulate Organic Carbon

Suspended POC (POC_{susp}) was collected using *in situ* pumps (Mac Lane and Challenger pumps) deployed for 2 hours. During each deployment, 150 to 1600 liters of seawater, depending of the depth and the pump characteristics, were filtered through a pre-filter (petex, 53µm) and a 1µm pore diameter, pre-combusted (550°C) quartz-fiber filters (142 mm diameter). For carbon isotope analyses, 25% of prefilter and six punches (2.5 cm diameter) of quartz filter were dried on board at 40°C.

At LSCE, quartz filters will be acidified and dried under vacuum. Then, they will be combusted in quartz tubes at 850°C. The concentration of POC (µg/l) at each depth will be determined from the pressure measurement of CO_2 gas obtained after combustion of each filter and the liters of water filtered. This will be compared with the measurements realize at VUB ANCHLAB. A total of 43 samples will be analyzed. Prefilters will also be analyzed depending of the amount of carbon.

Suspended particles collected using in situ pumps

Super 1

	Depth (m)	volume (l)	cast n°
Challenger 4	50	1084	1
Challenger 3	75	693	1
Challenger 1	75	952	3
Challenger 2	125	1316	1
Challenger 1	175	1008	1
Mc Lane 3	250	603	1
Mc Lane 2	500	612	1
McLane 1	***725***	***Blk***	***3***
Mc Lane 1	750	612	1
McLane 2	1200	974	3
Mc Lane 1	1250	1027	2
McLane 3	2700	913	3
Mc Lane 2	2750	978	2
Mc Lane 3	4700	994	2

Super 2

	Depth (m)	volume (l)	cast n°
McLane 1	30	491	2
INSU 4	75	1369	2
McLane 2	130	1041	2
INSU 1	***175***	***Blk***	***2***
INSU 2	250	1565	2
McLane 3	590	1983	2
Mc Lane 1	1450	922	1
Mc Lane 2	2900	1011	1
Mc Lane 3	3940	3940	1

Super 3

	Depth (m)	volume (l)	cast n°
McLane 3	20	152	2
Mc Lane 1	50	207	2
INSU 1	***80***	***Blk***	***2***
Mc Lane 2	230	230	2
INSU 7	***1038***	***Blk***	***1***
INSU 1	1048	1060	1
McLane 3	2023	950	1
McLane 2	4320	985	1

Super 4

	Depth (m)	volume (l)	cast n°
INSU 1	***30***	***-***	***2***
INSU 1	***40***	***-***	***1***
INSU 2	80	710	1
INSU 7	100	629	2
INSU 2	125	765	2
INSU 3	165	1213	1
Mc Lane 1	**240**	**-**	**2**
McLane 3	400	1156	1
INSU 3	749	1209	2
Mc Lane 2	1108	1017	1
INSU 7	***1685***	***Blk***	***1***
Mc Lane 2	1685	1012	2
Mc Lane 1	***2468***	***Blk***	***1***
McLane 3	2468	942	2

Super 5

	Depth (m)	volume (l)	cast n°
INSU 1	***20***	***Blk***	***2***
Mc Lane 1	50	658	1
McLane 2	90	789	1
Mc Lane 1	***115***	***Blk***	***2***
McLane 2	300	991	2
INSU 2	500	1522	2
INSU 1	***1200***	***Blk***	***1***
Mc Lane 3	1500	1259	2
INSU 7	***2500***	***-***	***2***
Mc Lane 3	3884	919	2

Sediment Organic Carbon

9 samples of sediment were collected in SUPER station 1 using the Octopus. One of the 8 cores was sectioned in a cold room (4°C) into 0.5-1 cm thick layers. For carbon isotope analyses, 2 g of sediments were sampled in these layers and dried in an oven at 40°C.

At the lab, the sediment will be acidified to remove carbonate and dried. Then, the sample will be combusted in quartz tubes at 850°C.

Dissolved Organic Carbon

50 seawater samples were collected.

Four liters of seawater were collected using Niskin bottles for radiocarbon analyzes in the five SUPER stations. Samples were also collected for concentration of DOC at the same depths (collaboration with R. Sempere, C. Pangiotopoulos, B. Charrière). Ten depths for each super station were chosen to obtain a profile of concentration and radiocarbon DOC with a higher resolution towards the surface. The seawater samples were filtered through pre-combusted (550°C) quartz-fiber filters (45 mm diameter). The filtrate was transferred to borosilicate bottles (2 litres), poisoned with saturated $HgCl_2$ solution and sealed on board.

At laboratory, the DOC samples will be acidified to remove DIC and oxidized using a system which is currently developed (Beaupré *et al,* 2007). This system combines ultraviolet oxidation and a vacuum line system to convert marine dissolved organic carbon into CO_2.

^{14}C and ^{13}C analyses

The CO_2 from DIC, POC, SOC and DOC will be converted to graphite targets and ^{14}C will be measured by accelerator mass spectrometry (Artémis, UMS 2572). Stable carbon isotope results will be performed on splits of CO_2 when the amount of carbon allows it. The δ^{13}C measurements will be made on a Finnigan Mat Delta +, IRMS.

3.5. Alkenones

Ullah Ezat (ullah.ezat@lsce.ipsl.fr)
Marie-Alexandrine Sicre (sicre@lsce.ipsl.fr, not onboard)
LSCE, CEA-CNRS-IPSL
Avenue de la Terrasse
FR-91190 Gif-sur-Yvette

Sea Surface Temperature (SST) is calculated by the alkenones index: alkenones are organic compounds (having 2, 3 or 4 double bonds) which are synthesized by coccolithophorids (especially E. huxleyi), they are poorly dissolved in seawater, consequently precipitate with other organics or mineral particles forming in this way an archive within the sediment.

Our objectives in this work are to search for important advection of coccoliths.

Sampling strategy

Seawater samples: alkenones were sampled by in situ pumping of several liters (30 L) filtered in ship laboratory using inlet ship-seawater supply. Samples were oven dried (~50°C).

Sediment samples: alkenones sampling was planed, but unfortunately our attempt was not very successful. Samples were wrapped in aluminium foil and preserved at -18°C.

Analyses

A total of 120 samples is brought back to the home-based laboratory for later analyses. The samples will be treated chemically by different organics solvents to obtain a total organics compound which will be separated in different fractions (hydrocarbons, fatty acids, alkenones, etc…). Finally alkenone fractions are reconcentrated and measured via gas chromatography.

4. EXPORT FLUXES, SCAVENGING RATES AND REMINERALISATION INVOLVED IN THE CARBON CYCLE

4.1. ^{210}Lead-^{210}Polonium disequilibrium in the 0-1000 m water column

Elisabet Verdeny (Person in charge, elisabet.verdeny@uab.es)
Núria Casacuberta (elisabet.casacuberta@uab.es)
José Luis Amado (joseluis.amado@uab.es)
Pere Masqué (pere.masque@uab.es, not onboard)
Universitat Autonoma de Barcelona
Bellaterra, Spain

Scientific motivation

^{210}Po ($T_{1/2}$ = 138.4 d) is a useful tracer for quantifying particle export from surface waters and the processes governing the dynamics of particles in the ocean (Cochran and Masqué, 2003). ^{210}Po is a daughter of a long lived parent, ^{210}Pb ($T_{1/2}$ = 22.3 y), of the ^{238}U decay series. The degree of disequilibrium between ^{210}Pb and ^{210}Po and the dynamics of association to particles can be used to assess scavenging rates, export fluxes, remineralization rates and role of types and/or composition of particles involved in these processes. The mesopelagic zone is the depth layer where most changes in sinking organic matter occur and also where SAMW and AAIW are formed. POC contents measured in sinking particles will be used to convert ^{210}Po fluxes into carbon fluxes.

Sampling methodology and sampling treatment on board

^{210}Pb and ^{210}Po total activities were measured from ~ 5 L seawater samples from Niskin bottles (CTD casts), from 20 depths between 0-1000 m. The high vertical resolution sampling undertaken in this project will allow assessing the vertical distribution of these elements in great detail.

Seawater samples for ^{210}Pb and ^{210}Po were pre-treated on board in order to pre-concentrate the activities of these radionuclides. Internal yields, stable Pb and ^{209}Po, were added to asses the procedural recovery. The pre-concentration was achieved by forming an $Fe(OH)_3$ precipitate that effectively scavenges Pb and Po from solution. The precipitate was then transferred to small volume HDPP bottles, for an easy transport to the home laboratory. The radiochemical analysis of these samples will be done at UAB, and the activity of the samples will be determined via high resolution alpha-spectrometry using surface barrier alpha detectors (UAB).

Sampling results

Seawater profiles of 20 depths (0-1000 m) for the ^{210}Pb-^{210}Po work were collected from a total of 8 stations (5 Super Stations and 3 Large Stations) along the transect from 36.3ºS 13.1ºE to 57.33ºS 0.0ºE. A total of 172 samples were collected, including 6 procedural blanks (3 at the beginning of the cruise and 3 at the end), and 5 duplicate samples to ensure reproducibility.

Compilation of samples collected for ^{210}Pb-^{210}Po

Station	Type of	Date			Type of sample
name	Station	of sampling	Lat (S)	Lon (E)	Pb-Po ppt
Sta. 18	SUPER 1	21/Feb/2008	36.29.755	13.06.997	20
Sta. 34	SUPER 2	27/Feb/2008	42.28.297	08.56.004	20
Sta. 41	Large B 1	02/Mar/2008	44.53.770	06.53.110	20
Sta. 48	SUPER 3	05/Mar/2008	47.33.290	04.22.540	21
Sta. 52	Large B 2	07/Mar/2008	49.01.678	02.49.874	22
Sta. 62	SUPER 4	11/Mar/2008	51.52.158	- 00.00.109	22
Sta. 65	Intercal.	12/Mar/2008	52.58.913	00.00.020	
Sta. 72	Large B 3	14/Mar/2008	55.13.948	00.02.611	20
Sta. 78	SUPER 5	16/Mar/2008	57.33.150	- 00.02.270	19
				TOTAL	164

4.2. Biogeochemical processes involved in carbon export and remineralization (^{234}Thorium, particulate barium)

The aim here is to achieve a better insight in: (i) particle vs solute interactions for organic carbon; (ii) the processes in control of organic carbon export and its transformation during transit through the mesopelagic depth region.

4.2.1. Export and shallow remineralization

Frédéric Planchon (frederic.planchon@africanmuseum.be)
Royal Museum for Central Africa
Dpt. of Geology and Mineralogy
Section of Mineralogy and Petrography
Leuvensesteenweg, 13
B- 3080 Tervuren
Belgium

Frank Dehairs (fdehairs@vub.ac.be)
Anne-Julie Cavagna (acavagna@vub.ac.be)
Vrije Universiteit Brussel
Laboratory for Analytical & Environmental Chemistry
Pleinlaan 2
B-1050 Brussels
Belgium

^{234}Th (and ^{210}Po; see work by Elisabet Verdeny's group) is useful to quantify the scavenging from solution onto particles and the processes governing the dynamics of particles in the ocean. These radionuclides have in common the fact that they both are daughters of a long lived parent (^{238}U) present in the dissolved phase and with conservative behaviour over the oceanic water column. Profiles of total ^{234}Th inform not only on the export of particles (from the deficit of ^{234}Th vs ^{238}U) from the mixed layer but also possibly on remineralization of these sinking particles below the mixed layer (from the ^{234}Thexcess relative to ^{238}U). We assessed the export of particles from the upper mixed layer using the ^{234}Th deficit method. This approach consists in recovering total ^{234}Th (i.e. dissolved and particulate) from a ^{230}Th-spiked 4L seawater sample by scavenging on Mn(OOH) precipitate and filtering on quartz filters. These filters are dried and counted on board for beta activity using a low beta RISØ counter. The ^{234}Th activity deficit relative to ^{238}U is integrated to yield a ^{234}Th flux associated with sinking particles. To transform this flux into a carbon flux the ^{234}Th activity exclusively associated with particles is also measured. To that purpose large volume filtrations are performed with in-situ pumps fitted with nylon screens (50 µm cut-off) and QMA quartz filters (1 µm cut-off). The material collected on the 50µm screens is washed off and reconcentrated on a 0.4 µm silver filter. QMA filters were subsampled using a cut-out (25 mm diameter). These filters were dried and counted on board. At this stage we only have a crud idea on the magnitude of the ^{234}Th export flux along BGH. Indeed samples need to be recounted in the home-based lab after about 6 months to assess background ^{234}Th activity (from scavenged ^{238}U) and to assess the yield of the original 234Th recovery by analyzing the concentration of ^{230}Th, the yield monitor used. After recounting, the filters with particulate ^{234}Th will be analysed for POC content using an elemental analyzer, in order to deduce ^{234}Th/POC ratios. Only then will it be possible to generate final numbers of POC export flux. Results will be compared with those obtained by Elisabet Verdeny on ^{210}Po and ^{210}Pb.

CTD rosette and in-situ pump casts for 234Th activity analysis

Station type	station number	date	CAST type	CAST Number	Latitude	longitude	depth range
Super 1	18	20/02/08 05:06	CTD Mixed Layer	20	13.06.974 E	36.31.536 S	0-50
Super 1	18	20/02/08 11:30	PIS	1	13.07.139 E	36.31.255 S	0-750
Super 1	18	20/02/08 15:52	Super1 REE 0-bottom	21	13.07.096 E	36.31.278 S	5000
Super 1	18	21/02/08 05:25	PIS	2	13.08.650 E	36.28.040 S	1250-4700
Super 1	18	21/02/08 09:00	CTD Po-Th	22	13.06.997 E	36.29.755 S	0-1000
Super 1	18	22/02/08 00:30	PIS	3	13.06.311 E	36.29.105 S	75-2700
Large 2B	31	25/02/08 21:40	CTD HYDRO	37	09.55.057 E	41.10.705 S	2600-bottom
Large 2B	31	26/02/08 01:37	CTD Mixed Layer	38	09.55.313 E	41.11.390 S	0-300
Super 2	34	27/02/08 12:04	PIS	4	08.55.723 E	42.28.134 S	0-3940
Super 2	34	27/02/08 20:30	CTD Po-Th	43	08.56.004 E	42.28.297 S	0-1000
Super 2	34	28/02/08 00:12	BaSi	44	08.55.912 E	42.28.130 S	1500
Super 2	34	28/02/08 07:30	PIS	5	08.55.960 E	42.28.110 S	0-1450
Large 3B	41	01/03/08 15:39	CTD Mixed Layer	52	06.53.114 E	44.53.801 S	0-300
Large 3B	41	01/03/08 23:36	CTD HYDRO	53	06.54.230 E	44.53.480 S	0-4110
Large 4A	44	03/03/08 08:15	CTD Mixed Layer	58	05.52.520 E	46.01.030 S	0-200
Super 3	48	05/03/08 06:50	PIS	6	04.22.160 E	47.33.160 S	1038-4340
Super 3	48	05/03/08 17:56	CTD Po-Th	65	04.22.540 E	47.33.290 S	0-1000
Super 3	48	06/03/08 03:07	PIS	7	04.22.845 E	47.33.056 S	0-550
Large 5B	52	07/03/08 12:27	CTD HYDRO	70	02.49.873 E	49.01.687 S	0-1000
Large 5B	52	07/03/08 14:39	CTD Mixed Layer	71	02.49.930 E	49.01.680 S	0-150
Large 6A	57	09/03/08 06:16	CTD Mixed Layer	78	01.19.432 E	50.22.698 S	0-250
Super 4	62	10/03/08 20:30	PIS	8	00.00.00 E	51.51.330 S	0-2468
Super 4	62	11/03/08 02:48	CTD Po-Th	86	00.00.109 W	51.52.158 S	0-1000
Super 4	62	11/03/08 15:49	PIS	9	00.00.00 E	51.51.330 S	0-2468
Large 7A	72	14/03/08 06:47	CTD Mixed Layer	100	00.00.021W	55.34.140 S	0-250
Large 7A	72	14/03/08 10:57	CTD HYDRO	101	00.00.330 E	55.34.230 S	0-1000
Super 5	78	to be completed	PIS	8	00.00.330 E	57.33 S	
Super 5	78	16/03/2008 18:44	CTD Po-Th	86	00.00.330 E	57.33 S	0-1000
Super 5	78	to be completed	PIS	9	00.00.330 E	57.33 S	

4.2.2. Mesopelagic remineralization

Frank Dehairs (fdehairs@vub.ac.be)
Vrije Universiteit Brussel
Laboratory for Analytical & Environmental Chemistry
Pleinlaan 2
B-1050 Brussels
Belgium

Damien Cardinal (damien.cardinal@africamuseum.be)
Royal Museum for Central Africa
Dpt. of Geology and Mineralogy
Section of Mineralogy and Petrography
Leuvensesteenweg, 13
B- 3080 Tervuren
Belgium

The accumulation of particulate authigenic Ba (mainly consisting of $BaSO_4$, barite formed in decaying aggregates of biogenic matter) in the mesopelagic water column (100 – 1000m) has been shown to correlate with subsurface bacterial activity and to reflect the intensity of past mesopelagic remineralization of exported organic matter.
We sampled several liters of seawater (4 to 10L) using the rosette casts at Large B and Super stations and filtered the water over 0.4 µm Nuclepore membranes under pressure of filtered air. Membranes are dried and saved till later analysis in the home based laboratory. Filters will be subsampled first for δ^{30}Si of bioSi in surface and also for SEM-EMP study of discrete barite microparticles present on the filter. The filter part for Ba will be subsequently digested using a tri-acid mix (HCl, HNO_3, HF). Ba (as well as Sr, Ca, Al, U, ..) will be analysed by HR-ICP-MS. Excess, non-lithogenic particulate Ba (Baxs) is calculated using Al as the crustal reference. A transfer function established earlier for the same area as BGH relating Baxs with oxygen consumption will be applied to deduce the rate of oxygen utilization and the rate of POC respired. These values will be compared with carbon export flux (obtained via the ^{234}Th method), with new production and new community production, both assessed by the group of Pedro Monteiro.

CTD Rosette casts sampled for particulate barium

CTD Cast #	Station type	Station	Date	Long	Lat	depth range
23	SUPER 1	1	21/02/2008	13.06.300 E	36.28.140 S	0-1000m
44	SUPER 2	34	27/02/2008	08.55.970 E	42.28.110 S	"
54	LARGE 3B	41	2/03/2008	06.53.130 E	44.53.740 S	"
66	SUPER 3	48	6/03/2008	04.22.480 E	47.33.310 S	"
72	LARGE 5B	52	7/03/2008	02.49.930 E	49.01.690 S	"
77	LARGE 6A	57	8/03/2008	01.18.130 E	50.22.360 S	"
87	SUPER 4	62	11/03/2008	00.00.410 E	51.52.540 S	"
99	LARGE 7A	72	14/03/2008	00.02.660 E	55.13.930 S	"
110	SUPER 5	78	16/03/2008	00.02.268 W	57.33.152 S	"

4.3. Carbon isotopes (^{14}C and ^{13}C) to trace marine carbon cycle in the water column

Nadine Tisnérat-Laborde (tisnerat@lsce.ipsl.fr)
Martine Paterne (paterne@lsce.ipsl.fr, not onboard)
LSCE/IPSL, CEA-CNRS-UVSQ
Domaine du CNRS
Bat 12
Avenue de la Terrasse
FR-91198 Gif-sur-Yvette

Scientific objectives

As explained here above in section 3.4., the aim of this study is to investigate the variation of radiocarbon and ™^{13}C signatures of the different forms of carbon in the water column and sediment in the inter-frontal region of Southern Ocean in order to contribute to understand the fate of carbon : ™^{13}C and $\otimes^{14}$C signatures of the different forms of organic matter (POC, DOC and SOC) reflect the balance between production and deposition. It is therefore possible to determine the partitioning of exported carbon between dissolved and particulate forms, and to understand, in conjunction with the other tracers, the factors which regulate the fate of these carbon pools.

Methods

See section 3.4.

5. BIOGEOCHEMICAL CYCLES AND PROCESSES

5.1. Distribution and internal cycle of silicon (^{30}Si)

5.1.1. Natural silicon isotopic composition

Damien Cardinal (damien.cardinal@africamuseum.be)
François Fripiat (francois.fripiat@africamuseum.be)
Royal Museum for Central Africa
Dpt. of Geology and Mineralogy
Section of Mineralogy and Petrography
Leuvensesteenweg, 13
B- 3080 Tervuren
Belgium

Samples were taken to compare the natural isotopic signatures of $Si(OH)_4$ and bio-silica (BSi) in order to better constrain the $Si(OH)_4$-diatom dynamics (Si utilization efficiency, mixing, Si source and accumulation). The isotopic composition of dissolved silicate ($\delta^{30}Si_{DSi}$) tends to integrate the effect of isotope fractionation over the growth season, while isotopic composition of particles ($\delta^{30}Si_{BSi}$) rather reflects the instantaneous result of fractionation. To that purpose seawater sampled per rosette during large and super stations was filtered on 0.4 µm Nuclepore membranes. Generally 19 depths were sampled from rosette casts for the determination of $\delta^{30}Si_{DSi}$ while filters will be available only on surface for $\delta^{30}Si_{BSi}$ due to the insufficient amount of particles below. Deeper $\delta^{30}Si_{BSi}$ will however be determined from the large volume in-situ pumps samples collected with Supor filters of 0.4 µm pore size at the Super stations. Filtrate and filtered particles were saved for chemical processing and isotopic analysis in the home based laboratory. After a thorough purification and preconcentration process, analyses will be carried out in the home-based laboratory (MRAC) by MC-ICP-MS in dry plasma mode using Mg external doping. Before the analyses we apply a wet-alkaline digestion on biogenic silica samples (2 M NaOH leaching at 100°C for 40 min). Silicon is then purified through its quantitative reaction with Triethylamine-Molybdate following by combustion (1000°C) and a HF/HCl dissolution. For samples with $Si(OH)_4$ lower than 10µM a MAGIC preconcentration step is first necessary.

CTD Rosette casts sampled for analysis of silicate and bioSi

Cast #	Station type	Station	Date	Long	Lat	depth range
19	SUPER 1	18	19/02/2008	13.07.320 E	36.31.370 S	1500 - bottom
23	SUPER 1	18	21/02/2008	13.06.000 E	36.25.999 S	0-1000
37	LARGE 2A	31	25/02/2008	09.55.010 E	41.10.560 S	0 - bottom
41	SUPER 2	34	26/02/2008	08.55.700 E	42.28.170 S	1400 - bottom
44	SUPER 2	34	27/02/2008	08.55.970 E	42.28.110 S	0 - 1000
53	LARGE 3B	41	1/03/2008	06.53.140 E	44.53.770 S	1250 - bottom
54	LARGE 3B	41	2/03/2008	06.53.130 E	44.53.740 S	0 - 1000
57	LARGE 4A	44	2/03/2008	05.51.890 E	46.01.450 S	0 - bottom
63	SUPER 3	48	4/03/2008	04.22.610 E	47.33.260 S	1400 - bottom
66	SUPER 3	48	6/03/2008	04.22.480 E	47.33.310 S	0 - 1000
70	LARGE 5B	52	7/03/2008	02.49.940 E	49.01.690 S	1500 - bottom
72	LARGE 5B	52	7/03/2008	02.49.930 E	49.01.690 S	0 - 1000
77	LARGE 6A	57	8/03/2008	01.18.130 E	50.22.360 S	0 - bottom

84	SUPER 4	62	10/03/2008	00.00.041 E	51.51.350 S	1200 - bottom
87	SUPER 4	62	11/03/2008	00.00.410 E	51.52.540 S	0 - 1000
98	LARGE 7A	72	13/03/2008	00.01.380 E	55.13.847 S	1500 - bottom
99	LARGE 7A	72	14/03/2008	00.02.660 E	55.13.930 S	0 - 1000
106	SUPER 5	78	15/03/2008	00.02.190 W	57.33.150 S	1250 - bottom
110	SUPER 5	78	16/03/2008	00.02.268 W	57.33.152 S	0 - 1000

5.1.2. Si isotopic dilution incubations

Rudolph Corvaisier (rudolph.corvaisier@univ-brest.fr)
Emilie Grossteffan (emilie.grossteffan@univ-brest.fr)
Philippe Pondaven (philippe.pondaven@univ-brest.fr, not onboard)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Damien Cardinal (damien.cardinal@africamuseum.be)
François Fripiat (francois.fripiat@africamuseum.be)
Royal Museum for Central Africa
Dpt. of Geology and Mineralogy
Section of Mineralogy and Petrography
Leuvensesteenweg, 13
B- 3080 Tervuren
Belgium

Isotope dilution experiments using 30Si spike additions were conducted at large and super stations. We will assess Si-uptake rates as well as bio-silica dissolution rates to determine the Si-budget and the impact of internal recycling on the Si-availability in the surface waters. Uptake rates will be compared with N and C uptake rates assessed by the group of Pedro Monteiro. In this regard, a common sampling strategy was implemented and samples were taken from the same CTD mixed layer casts and incubated simultaneously for C, N and Si for 24h at 100%, 25% and 1% light levels. In addition some 48h incubations were performed at super stations. Sample processing and analyses will be carried out in the home-based laboratory (MRAC, Tervuren) via HR-SF-ICP-MS. We also apply first an alkaline digestion on biogenic silica samples. For dissolved silicon, a preconcentration is applied, and for the samples with low Si(OH)$_4$ contents, a purification step on cationic exchange resin is necessary to overcome the matrix effect.

For 30Si incubations used for Uptake Rate of Si and Dissolution rate of BSi determination the addition of ^{30}Si tracer is 100% in order to get a better signal for dissolution rate measurement. This experiment is coupled, on the same water, with the 10% tracer addition incubation done by Fripiat & Cardinal which is more focused on uptake rate measurements. For each depth 3 different (triplicates) 2000mL PC bottles are incubated for 24h. Filters of BSi and 50mL tubes of filtered seawater for silicate measurement are sampled at t0 and t+24h. A preconcentration (MAGIC) of silicate is also performed to recover all the silicates in 20mL at the end. Filters are dried and stored at ambient temperature, 50mL seawater tubes and MAGIC tubes are stored at +4°C. BSi, silicates and ^{30}Si abundances will be analysed at the LEMAR, Plouzané.

Dilution experiments to determine growth parameters and grazing rates of diatoms using BSi as diatoms marker incubations have been done for 2 depths: 1%, and 100% PAR depth. For each depth, and for diluted and non-diluted biomass sample, 3 different (triplicates) 500mL PC bottles are respectively incubated for 24 and 48h. Filters of BSi and 50mL tubes of filtered seawater for silicate are sampled at t0, t+24h and t+48h. Filters are dried and stored at ambient temperature, 50mL seawater tubes are stored at +4°C. Both BSi and silicates will be analysed at the LEMAR, Plouzané

CTD Rosette casts sampled for Si uptake and bSi dissolution incubations

Cast #	Station type	Station	Date	Long	Lat	depth range
12	Large1A	11	17/02/2008	14.24.520 E	34.25.600 S	0 - 250
20	Super 1	18	20/02/2008	13.07.120 E	36.31.310 S	0 -300
38	Large 2B	31	26/02/2008	09.55.360 E	41.11.400 S	0 -300
45	Super 2	34	28/02/2008	08.56.050 E	42.28.110 S	0 - 250
52	Large 3B	41	1/03/2008	06.53.070 E	44.53.880 S	0 - 300
58	Large 4A	44	3/03/2008	05.52.390 E	46.01.010 S	0 - 200
62	Super 3	48	4/03/2008	04.22.610 E	47.33.160 S	0 - 250
71	Large 5B	52	7/03/2008	02.49.920 E	49.01.680 S	0 - 250
78	Large 6A	57	9/03/2008	01.18.930 E	50.22.480 S	0 - 250
83	Super 4	62	10/03/2008	00.00.040 E	51.50.870 S	0 - 250
100	Large 7A	73	14/03/2008	00.00.021 W	55.34.140 S	0 - 250
108	Super 5	78	16/03/2008	00.02.252 W	57.33.161 S	0 - 270

5.2. New and total production in the atlantic section of the Southern Ocean (^{15}N and ^{13}C incubations, natural abundance ^{15}N and ^{13}C isotopes variability, O_2 isotopes/Ar ratio)

Pedro Monteiro (pmonteir@csir.co.za)
Warren Joubert (wjoubert@csir.co.za)
Council for Scientific and Industrial Research, RSA, SA.

Howard Waldron (howard.waldron@uct.ac.za)
Sandy Thomalla (sandy_thomalla@yahoo.com)
University of Cape Town, RSA, SA.

O2 isotopes/Ar ratio:
Nicolas Cassar (ncassar@Princeton.EDU, not onboard)
Michael Bender (bender@princeton.edu, not onboard)
Princeton University, U.S.A.

Introduction

New production fluxes south of the Sub-Tropical Front (STF), particularly in the Sub-Antarctic Zone (SAZ) between 40 – 50°S are thought to make this region one of the most important oceanic sinks of atmospheric CO_2. This sink is driven by two main mechanisms: dissolution and subduction i.e. the “solubility pump” as well as phytoplankton export fluxes, the “biological pump”. The work undertaken on the Bonus-Goodhope Cruise focused on the characteristics and variability of the “Biological Pump”.

This region is characterised by a wide range of spatial (mesoscale features and meridional gradients) and temporal scales of variability. The basis for the variability of ocean productivity in the sub-Antarctic zone remains uncertain and the lack of observations also limits the validation of indirect model estimates to quantify productivity and export production. The BONUS-GOODHOPE research cruise has provided an opportunity to investigate physical and biogeochemical processes across the major fronts in the Atlantic sector of the Southern Ocean close to, and along, the 0° meridian.

A range of nitrogen dynamics and primary productivity experiments were conducted to investigate the role of the SAZ in respect of carbon sequestration via the biological pump. Hourly (day vs night) and daily rates of new- and total production within the euphotic zone will be estimated from the uptake rates of NO_3-N, NH_4-N, urea-N and carbon using ^{15}N- and ^{13}C-labelled salts. N- and C-uptake rates were also targeted in the micro- nano- and pico-plankton size fractions using surface water samples. This suite of experiments was supplemented by a series of three, 6-day incubations. These were designed to determine the new production (and hence carbon export) response of the ambient phytoplankton assemblage to the addition of iron. Experiments were conducted in iron-replete and –depleted oceanic environments. Net community production and gross primary production (which provides an estimate of export production, similar to the *f*-ratio) were determined using O_2/Ar and the triple oxygen isotope method. A high resolution underway sampling strategy was adopted using an equilibrator inlet mass spectrometer (EIMS), as well as discrete samples collected during rosette deployments.

In summary, the following work was undertaken:

- ^{15}N and ^{13}C tracer production experiments.
- New production response to iron addition (reported in a separated report).
- Natural abundance isotope variability
- Oxygen triple isotopes: Net Community Production

There should be useful synergies arising from the comparative analysis of carbon export fluxes derived from these two techniques (^{15}N uptake and O_2/Ar) and those that measure sub-seasonal (Th) and seasonal (Po) particle export fluxes.

Methods

- Production Measurements

Production measurements were undertaken using bulk water samples obtained from the 100, 50, 25, 10 and 1% light levels of the CTD Mixed Layer Depth (MLD) cast (Large stations, type A and B and Super stations). Occasionally, opportunistic sampling was undertaken at Hydrocast stations from water within the surface mixed layer (SML). These lower-volume bulk samples were used for the 50% light level, short-term incubations aimed at determining hourly day-time and night-time rates of N-uptake. In all cases, three, 2L sub-samples were pre-screened into borosilicate glass bottles (through a 200μm mesh to exclude grazers); for each light depth of the MLD cast as well as the single bulk sample from the SML short-term experiments. $^{15}NO_3$-N, $^{15}NH_4$-N and ^{15}urea-N salts were added to the respective sub-samples from the light depths and SML sub-samples and, in addition, ^{13}C salt was added to the $^{15}NO_3$-N bottle. ^{15}N and ^{13}C tracers were added at ≤10% of ambient nutrient concentrations. The bottles were incubated at simulated *in situ* light levels on deck and maintained at SST by continuous sea-water flow. The period of incubation was approximately 24h for the MLD and 4h for the short-term experiments. Experiments were terminated by filtration onto pre-ashed 47mm GF/F filters, which were then dried at 75°C and retained for particulate nitrogen, carbon and ^{15}N analysis. Initial concentrations of ammonium-N and urea-N were determined manually by colourimetric method and initial nitrate-N concentrations were available from the autoanalyser results. Size-fractionated (<2μm, 2–20μm and 20–200μm) chlorophyll-a and phaeo-pigments were determined fluorometrically for one bulk sample in the SML.

- Size fractionated production at the surface

Size fractionated nitrogen uptake and carbon fixation experiments were conducted using 20L bulk surface samples obtained using a plastic bucket. The bulk sample was pre-screened (200μm) and divided into three, 6L sub-samples, contained in clear polycarbonate incubation cylinders. The sub-samples were spiked *pro rata* with $^{15}NO_3$-N, $^{15}NH_4$-N, and ^{15}urea-N salts. A proportional amount of ^{13}C salt was also added to the $^{15}NO_3$-N bottle. The 3 samples were incubated at the simulated 50% light level, for 24h in each experiment. Each sample was then post-fractionated at <20μm and <2μm and filtered onto 47mm GF/F filters. Nitrogen uptake and carbon fixation rates will therefore be estimated for the <2μm, 2–20μm and 20–200μm (micro-, nano, and pico-) size fractions. Initial nutrient concentrations were obtained as previously. Size-fractionated (<2μm, 2–20μm and 20–200μm) chlorophyll-a and phaeo-pigments were determined fluorometrically on the initial bulk sample.

- Natural Abundance Isotope Variability

The objective of this part of the programme is to characterize the variability of POC/PON, ^{13}C and ^{15}N in the surface waters across the southern ocean. 2L samples were collected from the ships intake water supply every 8 hours. The samples were frozen and retained for particulate nitrogen and ^{15}N analysis.

- Oxygen isotopes NCP (EIMS)

High resolution measurement of the spatial variability of net community production using the O_2/Ar ratio and gross primary production oxygen triple isotope method was conducted underway. Anomalies of O_2/Ar relative to the long term atmospheric mean are driven by net autotrophic or heterotrophic activity. The export of carbon leaves a net positive anomaly that can be related to the net community production. The oxygen triple isotope ratios are used to derive estimates of gross primary production.

A continuous flow system that draws from the ship's scientific seawater supply was linked to a micro capillary equilibrator that separates the gas and water phases. The gas phase was analyzed on board using a Pheiffer quadrupole mass spectrometer. The system included an Aanderraa oxygen optode and a number of thermocouples used to continuously monitor the temperature at each stage of the sampling cycle. The sampling period was < 30 seconds.

The underway system was calibrated using samples collected through the same lab seawater supply in evacuated flasks for later analysis in dual inlet mass spectrometer. The discrete lab samples were compared to *in situ* samples of surface water taken periodically from the Rosette. Small differences in the oxygen concentrations were monitored through periodic simultaneously sampling of both lab supply and surface waters for Winkler analysis.
Station information is summarized in Tables 1 – 5.

Table 1	^{15}N Production incubations station and sampling information for mixed layer depth casts during LARGE stations on the BONUS GOODHOPE transect.
Table 2	^{15}N Production incubations station and sampling information for mixed layer depth casts during SUPER stations on the BONUS GOODHOPE transect.
Table 3	Size fractionation production incubations and short term production incubation station and sampling information for surface samples on the BONUS GOODHOPE transect.
Table 4	Natural abundance isotope variability samples collected underway from the ships scientific seawater supply system.
Table 5	O_2/Ar samples collected underway from the ship's scientific seawater supply as well as from surface rosette samples, for comparison between these two water sources.

Table 1- ^{15}N Production incubations station and sampling information for mixed layer depth casts during LARGE stations on the BONUS GOODHOPE transect.

Station	Station Label	CTD	mon/day/yr	Lat (°N)	Lon (°E)	% light	Depth [m]	Sample volume (L)
11	11 L1	12	02/17/2008	-34.43	14.41	100	1	6
11	11 L1	12	02/17/2008	-34.43	14.41	50	5	6
11	11 L1	12	02/17/2008	-34.43	14.41	25	10	6
11	11 L1	12	02/17/2008	-34.43	14.41	10	50	6
11	11 L1	12	02/17/2008	-34.43	14.41	1	80	6
31	31 L2 B	38	02/26/2008	-41.19	9.92	100	3.5	6
31	31 L2 B	38	02/26/2008	-41.19	9.92	50	3.5	6
31	31 L2 B	38	02/26/2008	-41.19	9.92	25	7	6
31	31 L2 B	38	02/26/2008	-41.19	9.92	10	15	6
31	31 L2 B	38	02/26/2008	-41.19	9.92	1	36	6
41	41L3	52	03/01/2008	-44.90	6.88	100	20	6
41	41L4	52	03/01/2008	-44.90	6.88	50	20	6
41	41L5	52	03/01/2008	-44.90	6.88	25	20	6
41	41L6	52	03/01/2008	-44.90	6.88	10	40	6
41	41L7	52	03/01/2008	-44.90	6.88	1	60	6
44	44LA	58	03/03/2008	-46.02	5.87	100	11	6
44	44LA	58	03/03/2008	-46.02	5.87	50	11	6
44	44LA	58	03/03/2008	-46.02	5.87	25	21	6
44	44LA	58	03/03/2008	-46.02	5.87	10	21	6
44	44LA	58	03/03/2008	-46.02	5.87	1	48	6
52	52 L5 B	71	03/07/2008	-49.03	2.83	100	5	6
52	52 L5 B	71	03/07/2008	-49.03	2.83	50	5	6
52	52 L5 B	71	03/07/2008	-49.03	2.83	25	10	6
52	52 L5 B	71	03/07/2008	-49.03	2.83	10	15	6
52	52 L5 B	71	03/07/2008	-49.03	2.83	1	60	6
57	57 L6 B	78	03/09/2008	-50.37	1.32	100	1	6
57	57 L6 B	78	03/09/2008	-50.37	1.32	50	1	6
57	57 L6 B	78	03/09/2008	-50.37	1.32	25	10	6
57	57 L6 B	78	03/09/2008	-50.37	1.32	10	15	6
57	57 L6 B	78	03/09/2008	-50.37	1.32	1	80	6
72	72LB	100	03/14/2008	-55.57	0.004	100	5	6
72	72LB	100	03/14/2008	-55.57	0.004	50	5	6
72	72LB	100	03/14/2008	-55.57	0.004	25	13	6
72	72LB	100	03/14/2008	-55.57	0.004	10	24	6
72	72LB	100	03/14/2008	-55.57	0.004	1	109	6

Table 2- ^{15}N Production incubations station and sampling information for mixed layer depth casts during SUPER stations on the BONUS GOODHOPE transect.

Station	Station Label	CTD	mon/day/yr	Lat (°N)	Lon (°E)	% light	Depth [m]	Sample volume (L)
18	18 S1	20	02/20/2008	-36.52	13.12	100	3.4	6
18	18 S1	20	02/20/2008	-36.52	13.12	50	7.5	6
18	18 S1	20	02/20/2008	-36.52	13.12	25	14.2	6
18	18 S1	20	02/20/2008	-36.52	13.12	10	39.7	6
18	18 S1	20	02/20/2008	-36.52	13.12	1	53.7	6
18	18 S1	22	02/21/2008	-36.51	13.12	100	1	6
34	34 S2	45	02/28/2008	-42.47	8.93	100	3	6
34	34 S2	45	02/28/2008	-42.47	8.93	50	5	6
34	34 S2	45	02/28/2008	-42.47	8.93	25	10	6
34	34 S2	45	02/28/2008	-42.47	8.93	10	22	6
34	34 S2	45	02/28/2008	-42.47	8.93	1	50	6
48	S3 (MLD)	62	03/04/2008	-47.55	4.38	100	3.77	6
48	S3 (MLD)	62	03/04/2008	-47.55	4.38	50	3.77	6
48	S3 (MLD)	62	03/04/2008	-47.55	4.38	25	9	6
48	S3 (MLD)	62	03/04/2008	-47.55	4.38	10	20	6
48	S3 (MLD)	62	03/04/2008	-47.55	4.38	1	59	6
62	62 S4	83	03/10/2008	-51.85	0.00	100	5	6
62	62 S4	83	03/10/2008	-51.85	0.00	50	5	6
62	62 S4	83	03/10/2008	-51.85	0.00	25	10	6
62	62 S4	83	03/10/2008	-51.85	0.00	10	25	6
62	62 S4	83	03/10/2008	-51.85	0.00	1	125	6
80	S5	108	03/16/2008	-57.55	0.04	100	5	6
80	S5	108	03/16/2008	-57.55	0.04	50	5	6
80	S5	108	03/16/2008	-57.55	0.04	25	10	6
80	S5	108	03/16/2008	-57.55	0.04	10	30	6
80	S5	108	03/16/2008	-57.55	0.04	1	90	6

Table 3- Size fractionation production incubations and short term production incubation station and sampling information for surface samples on the BONUS GOODHOPE transect.

Station	Station Label	CTD	experiment	mon/day/yr	Lat (°N)	Lon (°E)	% light	Depth	Sample volume (L)
15	15 Hydro	16	SF	02/18/2008	-35.63	13.68	100	surface	18
18	18 S1 SF	22	SF	02/21/2008	-36.31	13.07	100	surface	18
27	27 SF	27	SF	02/23/2008	-37.55	12.35	100	surface	18
29	29 SF	34	SF	02/25/2008	-40.29	10.55	100	surface	18
42	42	55	Day	03/02/2008	-45.33	6.50	100	ML	6
47	47 SF	61	SF	03/04/2008	-47.32	4.62	100	surface	18
48	S3	66	SF	03/06/2008	-47.56	4.37	100	surface	18
62	62 S4	85	Night	03/10/2008	-51.86	0.01	100	ML	6
65	65Int	90	Day	03/12/2008	-52.93	0.00	100	ML	6
70	70SF	96	SF	03/13/2008	-54.58	0.00	100	1	18
76	76SF	104	SF	03/15/2008	-56.76	0.01	100	1	18

SF : size fractionated incubation
Day: short term daytime incubation.
Night: short term nighttime incubation.

Table 4- Natural abundance isotope variability samples collected underway from the ships scientific seawater supply system.

Date + UTC	*Underway Natural Abundance samples*			
	FilterNumber	*Time*	*Lat*	*Long*
16/02/2008 14:00	bgh1	14h10	34o04.76	15o04.10
16/02/2008 22:00	bgh2	21h40	34o07.329	14o34.956
17/02/2008 06:00	bgh3	06h00	34o25.560	14o24.320
17/02/2008 14:00	bgh4	14h05	34o31.931	14o20.025
17/02/2008 22:00	bgh5	22h00	34o53.746	14o07.188
18/02/2008 06:00	bgh6	05h55	35o15.031	13o54.571
18/02/2008 14:00	bgh7	16h20	35o37.514	13o41.012
18/02/2008 22:00	bgh8	21h45	35o55.316	13o31.945
19/02/2008 06:00	bgh9	08h15	35o15.5	13o29.8
19/02/2008 14:00	bgh10	16h05	36o26.531	13o10.457
19/02/2008 22:00	bgh11	22h00	36o31.248	13o07.104
20/02/2008 06:00	bgh12	06h00	36o31.257	13o07.140
20/02/2008 14:00	bgh13	16h00	36o31.252	13o07.130
20/02/2008 22:00	bgh14	21h55	36o31.820	13o07.342
21/02/2008 06:00	bgh15	06h10	36o30.712	13o07.330
21/02/2008 14:00	bgh18	16h10	36o27.534	13o06.059
21/02/2008 22:00	bgh19	21h45	36o29.781	13o06.657
22/02/2008 06:00	bgh20	06h03	36o27.547	13o07.201
22/02/2008 14:00	bgh21	13h55	36o47.343	12o56.477
22/02/2008 22:00	bgh22	22h00	37o24.889	12o32.873
23/02/2008 06:00	bgh23	06h05	37o42.949	12o21.138
23/02/2008 14:00	bgh24	15h15	38o05.511	12o05.123
23/02/2008 22:00	bgh25	21h50	38o27.516	11o49.784
24/02/2008 06:00	bgh26	06h10	38o49.561	11o34.498
24/02/2008 22:00	bgh28	21h55	39o33.54	11o03.73
25/02/2008 06:00	bgh29	06h30	40o17.457	10o33.003
25/02/2008 14:00	bgh31	14h15	40o43.939	10o12.880
25/02/2008 22:00	bgh32	21h45	41o10.693	9o54.999
26/02/2008 06:00	bgh33	06h30	41o36.548	9o35.033
26/02/2008 14:00	bgh34	14h00	42o02.245	9o16.246
27/02/2008 06:00	bgh35	05h50	42o28.144	8o55.725
27/02/2008 14:00	bgh37	14h05	42o28.134	8o55.731

27/02/2008 22:00	bgh38	06h10	42o28.12	8o55.96
28/02/2008 06:00	bgh39	08h20	42o28.11	8o56.01
28/02/2008 14:00	bgh40	14h00	42o53.619	8o33.941
28/02/2008 22:00	bgh41	22h00	43o19.78	8o13.67
29/02/2008 06:00	bgh42	06h30	44o02.4638	7o37.910
29/02/2008 14:00	bgh43	14h00	44o12.9901	7o29.1520
02/03/2008 06:00	bgh45	08h30	45o19.308	6o30.775
02/03/2008 14:00	bgh46	14h00	45o31.4105	6o19.185
02/03/2008 22:00	bgh47	20h00	45o50.260	6o00.258
03/03/2008 06:00	bgh48	06h43	46o00.9026	5o52.5160
03/03/2008 14:00	bgh49	14h00	46o21.396	5o32.66
03/03/2008 22:00	bgh50	22h00	46o50.7856	5o04.3836
04/03/2008 06:00	bgh51	08h30	47o19.064	4o37.2075
Date + UTC	*Underway Natural Abundance samples*			
	FilterNum	*Time*	*Lat*	*Long*
04/03/2008 22:00	bgh52	22h00	47o33.1654	4o22.363
05/03/2008 06:00	bgh53	11h50	47o32.8733	4o22.0924
05/03/2008 22:00	bgh54	11h10	47o46.1869	4o09.4437
06/03/2008 22:00	bgh55	22h00	48o22.7728	3o31.5045
07/03/2008 22:00	bgh56	21h45	49o01.6828	2o49.93
08/03/2008 14:00	bgh57	10h00	49o49.9685	1o55.7695
08/03/2008 22:00	bgh59	20h45	50o07.8974	1o36.1175
09/03/2008 06:00	bgh60	10h30	50o38.1074	00o56.7079
09/03/2008 14:00	bgh61	20h30	51o10.2409	00o20.0162
10/03/2008 06:00	bgh62	10h15	51o52.1379	00o00.8109
10/03/2008 14:00	bgh63	22h00	51o51.4821	00o00.6702
11/03/2008 22:00	bgh64	00h50	52o16.3845	00o00.1633
13/03/2008 06:00	bgh69	06h00	54o15.012	0o00.0
13/03/2008 14:00	bgh66	11h34	54o39.9116	0o04.2234
13/03/2008 22:00	bgh67	00h10	55o14.0238	00o02.3864
14/03/2008 14:00	bgh68	16h00	55o54.2646	00o06.7938
15/03/2008 14:00	bgh85	13h30	57o12.7345	0o06.7966
16/03/2008 22:00	bgh84	22h00	57o33.1471	00o02.1885
17/03/2008 22:00	bgh83	22h00	55o52.4537	01o55.4469
18/03/2008 14:00	bgh82	14h00	53o41.073	04o42.297

Table 5- O_2/Ar samples collected underway from the ship's scientific seawater supply as well as from surface rosette samples, for comparison between these two water sources.

Date	station #	ctd #	Station type	Lat	Lon	O2/Ar (lab)	O2/Ar(cast)	DO(lab)		DO (cast)	
								bottle #	ml/l	bottle #	ml/l
17/02/2008	11	11	ML (large)	34o25.5	14o24.3	x	1024	324	4.969	448	5.226
20/02/2008	18	19	S1	36o31.3	13o07.1	x	1004	321	5.13	366	5.325
21/02/2008	18	21	S1	36o31.3	13o07.1	x	x	451	5.09	71	5.429
24/02/2008	27	32	hydro	39o33.5	11o03.7		1062	x		x	
25/02/2008	29	34	hydro	40o17.5	10o33.0	935	66	x		x	
25/02/2008	31	37	L2	41o10.6	9o.55.0	x	1021	318	5.873	158	5.984
27/02/2008	34	43	S2	42o28.3	8o56.1	1026	1064	114	6.304		
28/02/2008	34	45	S2 (ML)	42o28.1	8o56.0	x	1040	169	6.208	x	
28/02/2008	36	47	hydro	43o19.8	8o13.7	x	877	118	5.855	366	5.965
29/02/2008	38	49	hydro	44o02.5	7o37.9	x	57	161	6.486	158	6.551
01/03/2008	41	51	ML (large)	44o53.9	6o53.1	110	x	339	6.612	407	6.528
02/03/2008	42	56	hydro	45o19.3	6o30.8	849	82	469	4.743	492	6.622
02/03/2008	43	56	hydro	45o36.5	6o12.6	x	98	x		x	
03/03/2008	44	57	ML (large)	46o00.9	5o52.6	64		325	6.675	81	6.783
03/03/2008	46	60	hydro	46o43.3	5o11.8		1077	26	6.845	32	6.903
04/03/2008	48	63	S3 (ML)	47o33.3	4o22.6	37	72	49	6.9	38	6.954
05/03/2008	48	65	S(Th-cast)	47o33.3	4o22.6	929	856	x		x	
06/03/2008	49	67	hydro	47o58.2	3o57.5	1061	1201	119	6.974	451	6.989
07/03/2008	52	71	ML (large)	49o01.7	2o49.9	39	1006	83	7.127	54	7.067
08/03/2008	53	73	hydro	49o34.1	2o14.2	840	928	109	7.126	113	7.139
08/03/2008	55	75	hydro	49o50.5	1o55.8	4	850	119	7.2	451	7.232
08/03/3008	57	78	ML (large)	50o22.5	1o18.9	846	843	x		x	
09/03/2008	59	80	hydro	50o54.2	00o39.3	93	955	169	7.501	161	7.51
10/03/2008	62	83	S4 (ML)	51o51.0	0o00.0	997	9	73	7.632	54	7.68
12/03/2008	65	90	hydro	52o56.3	0o00.0	899	1092	48	7.718	112	7.798
12/03/2008	66	92	hydro	53o15.7	00o00.1	891	949	110	7.815	46	7.815

13/03/3008	70	94	hydro	54o34.8	00o00.0	932	938	328		x	
13/03/2008	72	96	hydro	55o14.4	0o00.0	904	115	412	7.836	155	7.827
14/03/2008	73	100	ML (large)	55o34.1	00o00	947	1018	122	7.745	81	7.832
14/03/2008	74	102	hydro	55o54.3	00o06.8	87	976	418	7.968	407	7.883
15/03/2008	76	105	hydro	56o46	00o00	x	1031	484	7.887	162	7.907
16/03/2008	78	108	S5 (ML)	57o33.2	00o02.3	x	x	499	7.879	459	7.768
17/03/2008			Intake	56o13.8	1o54.3	902	x	x		x	
18/03/2008			Intake	54o47.7	3o06.8	114	x	x		x	
18/03/2008			intake	53o41.1	04o42.3	1070	x	x		x	
18/03/2008			Provor	52o58	5o48	116	908	x		x	
18/03/2008			intake	52o16.8	06o51.0	107	x	X		x	
18/03/2008			Provor	50o38.9	9o14.2	1052	1062	X		x	
19/03/2008			intake	48o09.0	12o46.9	956	x	X		x	
19/03/2008			Provor	49o15.7	11o13.6	105	1076	x		x	
20/03/2008			intake	46o29.8	15o01.8	40	x	x		x	
20/03/2008			intake	44o06.2	18o48.7	832	x	x		X	
21/03/2008			intake	42o49.9	20o53.3	1089	x	x		X	
21/03/2008			Provor					x		X	

5.3. Specific biogenic compounds ($\delta^{13}C$ isotopic signatures of biomarkers)

Anne-Julie Cavagna (acavagna@vub.ac.be)
Frank Dehairs (fdehairs@vub.ac.be)
Vrije Universiteit Brussel
Laboratory for Analytical & Environmental Chemistry
Pleinlaan 2
B-1050 Brussels
Belgium

The content and carbon isotopic composition of specific organic compounds (total lipid extract and phospholipid derived fatty acids) characteristic for specific plankton groups (diatoms, dinoflagellates, coccolithophorids) will be assessed to yield information on the contribution of major phytoplankton groups to the suspended organic carbon pool, on differential changes of the lipid constituents with depth (and age) and on possible alteration of $\delta^{13}C$ isotopic signatures during remineralization. Samples were taken by large volume in-situ pumps fitted with nylon screen (cut-off 50 µm) and QMA quartz filters (cut-off 1 µm). Samples were deep frozen and saved for later analysis. A modified Bligh and Dyer extraction method will be applied on samples to extract total lipids, and after sylilation samples will be analyzed on GC-MS and GC-c-IMRS to assess $\delta^{13}C$ isotopic signatures and compounds determination in the home based laboratory (VUB)

In Situ Pump casts sampled for biomarkers

ISP Cast #	Station type	Station	Date	Long	Lat	depth range
1	SUPER 1	18	20/2/2008	13.07.14 E	36.31.25 S	50 - 750m
2	SUPER 1	18	20/2/2008	13.07.33 E	36.31.80 S	1250 - 4700m
3	SUPER 1	18	21/2/2008	13.06.70 E	36.29.60 S	75 - 2700m
4	SUPER 2	34	27/2/2008	08.55.72 E	42.28.13 S	75 - 3950m
5	SUPER 2	34	28/2/2008	08.55.96 E	42.28.11 S	30 - 1450m
6	SUPER 3	48	5/3/2008	04.22.16 E	47.33.16 S	1000 - 4400m
7	SUPER 3	48	6/3/2008	04.22.84 E	47.33.06 S	20 - 550m
8	SUPER 4	62	10/3/2008	00.00.00 E	51.51.33 S	40 - 2500m
9	SUPER 4	62	11/3/2008	00.00.00 E	51.51.33 S	30 - 2500m
10	SUPER 5	78	16/03/08	00.02.19 W	57.33.14 S	50 - 3900m
11	SUPER 5	78	17/03/08	00.03.03 W	57.33.08 S	20 - 2500m

5.4. Boron isotopes in the Southern Ocean

Eric Douville (douville@lsce.ipsl.fr, not onboard)
Nadine Tisnérat-Laborde (tisnerat@lsce.ipsl.fr)
LSCE/IPSL, CEA-CNRS-UVSQ
Domaine du CNRS - Bat 12
Avenue de la Terrasse
F-91198 Gif-sur-Yvette

Introduction and scientific objectives

Increasing acidity of the surface ocean, in response to anthropogenic emission of CO_2 into the atmosphere, is a subject of preoccupation as it may have severe consequences for marine calcifying organisms, which build their external skeleton out of calcium carbonate $CaCO_3$ (Orr et al., 2005). During the last 200 years, roughly fifty per cent of the anthropogenic CO_2 (IPCC, 2005) contributed to the acidification of the superficial ocean by 0.1 pH-units, and sea surface pH could drop to ~ 0.4 units by the year 2100 if carbon emission increases on the present–day trend (Caldeira and Wickett, 2003). Quantifying changes of the oceanic pCO_2 over the last centuries and over thousands of years is therefore of importance to better evaluate links between oceanic and atmospheric changes of pCO_2 and their consequences on ecosystems. Past sea surface pH may be deduced from the boron isotopic composition ($\delta^{11}B$) of biogenic carbonates such as foraminifera and surface or deep-sea corals. This "$\delta^{11}B_{carbonate}$ – $pH_{seawater}$" indicator would have the potential to calculate seawater pH change of 0.02 pH-unit in the past only if different assumptions are verified. Among the assumptions, it's commonly considered that the isotopic composition of boron (long residence time) for seawater is homogeneous in the Global Ocean about 40 ‰. Here, we suggested to precisely measuring this parameter ($\delta^{11}B_{SW}$) on MC-ICPMS in order to verify its stability, first, in different geographical locations and second in the water column, especially in the oxygen minimum zone.

Methods

141 seawater samples were collected for Boron analyses.
50 ml of seawater were collected for depth profile (14-20 depths) using Niskin bottles in the five SUPER stations and LARGE stations 1, 4, 5 and 7. Seawater was poisoned with 1drop of saturated $HgCl_2$ solution.

Station	L1 - St11	S1 - St18	S2 - St34	L4 - St44	S3 - St48	L5 - St52	S4 - St62	L7 - St72	S5 - St78
hydro cast	15	14	14	14	14	15	14	15	20
tap			1		1	1	1	1	1

Once back in the lab, Boron in seawater samples will be extracted and purified on anion exchange resin Amberlite IRA 743. About 5 ml is used for this extraction. The isotopic composition of boron will be measured by using new generation of mass spectrometer MC-ICPMS with a precise bracketing approach.

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6. INTERCOMPARISON OF GEOTRACES VARIABLES with the German *R.V. Polarstern*

Marie BOYE
LEMAR- IUEM- Technôpole Brest Iroise- FR-29280 Plouzané
marie.boye@univ-brest.fr

Onboard Marion Dufresne: Marie Boye, François Lacan, Frank Dehairs, Damien Cardinal, Johann Bown, François Fripiat, Fanny Chever. *Not onboard*: Catherine Jeandel, Matthieu Roy-Barman, Rémi Losno

Onboard Polarstern: Hein de Baar, Ingrid Voge, Patrick Laan, Celia Venchiarutti, Elizabeth Sweet, Charles-Edouard Thuroczy, Loes Gerringa, Peter Croot. *Not onboard*: Michiel Rutgers van der Loeff, Christina de la Rocha

For the sections from Capetown to the zero meridian, and from there along zero meridian to Antarctica, the GEOTRACES-CASO program of BONUS-GOODHOPE program (MD166) aboard Marion Dufresne is complementary to the Polarstern ANT XXIV-3. Towards an overall integrated database of both expeditions, some intercomparison between both programs was envisioned.

Before departure from Capetown, where Polarstern was also in port, there has been a meeting onboard Polarstern for organizing the intercomparison. This had to be modest for following reasons:

- departure of both vessels from Capetown was delayed with many days for various reasons, at expense of scientific stations time
- adverse weather conditions in the Southern Ocean will cause more time losses
- the extensive research objectives of both expeditions are very ambitious
- the number of pre-cleaned sample bottles onboard both ships is limited

The agreed strategy was twofold. Firstly the initial cruise tracks of Marion Dufresne and Polarstern were scheduled to be overlapping, and this, in principle, allows the positioning of stations and sampling depths at the same place. This is the strategy of choice for intercomparison of CO_2 system measurements (see further report intercomparison of CO_2), and for major nutrients. Secondly for a limited number of variables, it was decided that both ships would take a small number of duplicate samples, to be exchanged after the expeditions are completed, for final analyses in the home laboratories. These variables are Barium, dissolved trace metals, Neodymium, Thorium-Isotopes, Protactinium, Rare Earth Elements, and Silicon isotopes.

Once at sea, Polarstern by its earlier departure was further south than Marion Dufresne. At 26 February 2008 the positions and sampling depths of thus far completed Polarstern stations (then until 59°S, 0°W) were communicated by H.H.W. de Baar to M. Boye aboard Marion Dufresne, as to allow their re-occupation of selected same stations, their overall research program and weather permitting.

The Bonus-GoodHope team aboard Marion Dufresne collected several replicate samples (*Fig.8*) for dissolved trace metals (Marie Boye & Johann Bown) at 10 depths at 47°33.16' S, 4°22.36 E (S3/GF-19 cast at 04.03.2008; *Table 6*), 3 replicate samples (François Lacan) for Nd/Th/Pa/REE at 52°59'S, 0°E (CTD-91, 12.03.08; *Table 7*); 22 duplicates (Frank Dehairs) for dissolved Ba at 46°01'.45 S, 05°51'.89 E (CTD-57, 03-04.03.08; *Table 8*); and 7 duplicates (Damien Cardinal & François Fripiat) for Si isotopes at 55°13'.93 S, 00°02'.66 E (L7/CTD-99 cast, 14.03.08; *Table 9*).

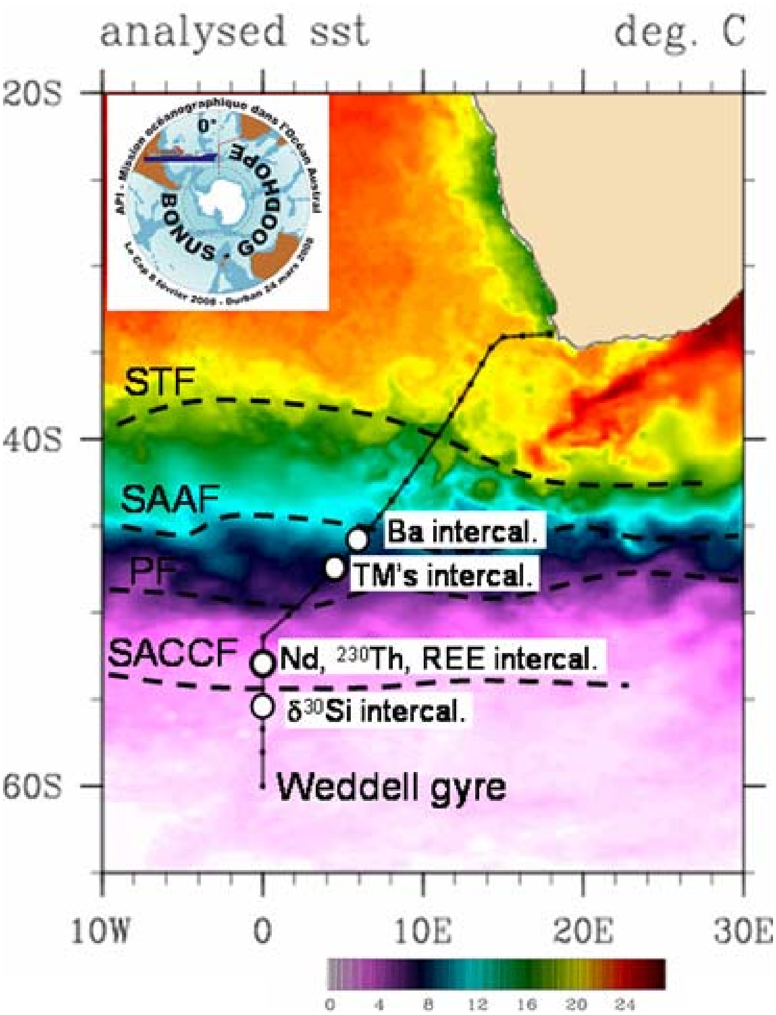

Figure 8- stations positions for the GEOTRACES intercomparison excercice during BONUS-GOODHOPE (SST data from Cersat/Odyssea at 08/02/26)

Similarly at Polarstern were collected 10 duplicate filtered seawater samples (Patrick Laan) for trace metals at 47°40' S, 4°17' E (PS71-104-2 at 16.02.2008); 3 duplicate samples (Celia Venchiarutti) for Nd/Th/Pa and REE at 52°59.58'S 0°2.39'E (PS71/113-4 at 20.02.08); 12 duplicate samples (Ingrid Voge) for Barium at 46 °S, 5°53' E (PS71-103-1 at 16.02.2008); and 7 duplicates (Elizabeth Sweet) for Si isotopes at 53°31' S, 0° 0.30'E

Table 6 – Trace metals intercomparison (GO-FLO cast)

BONUS-GOODHOPE (Marion Dufresne II)
Cast leader: Marie Boye
Sampling: Johann Bown & Marie Boye

THIRD SUPER STATION
Station number: GF19
Cast number: S3-GF19
Date start (UTC): 04/03/08 **Time start (UTC): 19H10** **Position start (°'): 47°33.1658 S/ 04°22.3625 E**
Date end (UTC): 04/03/08 **Time end (UTC): 22H50** **Position end (°'): 47°33.160 S/ 04°22.3703 E**
Closer CTD number: 63
Bottom depth:
with microcat

		Marie Boye for Patrick Laan **Intercal.** filtered	Marie Boye **Library** filtered	Johann Bown **Zn/Co/Cd** filtered	Bronwyn Wake **trace metals** filtered	Fanny Chever **Fe** filtered	For Rémi Losno **trace metals** filtered	For Peter Croot **Al** filtered	For Loes Gerringa **Zn/Co/Cd/Fe** filtered	Johann Bown **Zn/Co/Cd-orga** filtered	For Loes Gerringa **Zn/Co/Cd/Fe-orga** filtered	Annick Masson & Frederic Le Moigne	Volfango Ruppolo	Ifremer	
GO-FLO	**Target depth (m)**	**Intercal. conc.**	**Library LEMAR**	**Zn/Co/Cd (voltam.)**	**Trace metals (ICPMS)**	**Fe (FIA-chem.)**	**Trace metals (ICPAES)**	**Al (FIA-chem)**	**Zn/Co/Cd/Fe**	**OrgaZn/Co/Cd**	**OrgaZn/Co/Cd**	**NO3/Si**	**S**	**microcat**	**COMMENTS**
10	50	X	X	X	X	X	X	X	X	X	X	X	X	X	
9	200	X	X	X	X	X	X	X	X	X	X	X	X	X	
8	400	X	X	X	X	X	X	X	X			X	X	X	
7	750	X	X	X	X	X	X	X	X			X	X	X	
6	1000	X	X	X	X	X	X	X	X	X	X	X	X	X	
5	1750	X	X	X	X	X		X	X			X	X	X	leakage, prb of cartridge (1 for the 5L, and then new one for the rest used after sampling #1-4)
4	2000	X	X	X	X	X	X	X	X	X	X	X	X	X	
3	2500	X	X	X	X	X	X	X	X			X	X	X	
2	3000	X	X	X	X	X	X	X	X			X	X	X	
1	3500	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Volume per depth (ml)	2500	2500	250	250	60	120	125	250	1000	1000	125	100		**8280**
	Storage	HCl ultra. 30%, pH 1.8	HCl ultra. 30%, pH 1.8	HCl ultra. 30%, pH 1.8	HNO3 ultra.	HCl	HCl (seastar)	HCl ultra. 30%, pH 1.8	HCl ultra. 30%, pH 1.8	frozen	frozen	analysed on board	analysed on board		

Table 7 – Nd/Th/Pa/REE intercomparison (Niskin cast)

BONUS-GOODHOPE (Marion Dufresne II)
Cast leader: François Lacan

lat	long
52°59S	0°
12 march 08	14h UTC

	Jeandel-Lacan	Jeandel-RoyBarman	Jeandel-RoyBarman	Jeandel-Lacan
Target depth (m)	dissolved Nd isotopes	dissolved 230Th concentration	dissolved 231Pa concentration	dissolved REE concentration
380m	x	x	x	x
500m	x	x	x	x
1000m	x	x	x	x

Table 8 – dissolved-Barium intercomparison (Niskin cast)

BONUS-GOODHOPE (Marion Dufresne II)
Sampling: Frank Dehairs
CTD 57

Date start (UTC): 03/03/08
Date end (UTC): 04/03/08
Time start (UTC): 23:47
Time end (UTC): 03:08
Position start: 46°01.45S / 05°51.89 E
Position end: 46°01.55 S / 05°52.13 E
Seafloor: 4100m

Niskin	dbar	depth	dissolved barium	
1	4147	4075	X	
2	3802	3735	X	
3	3501	3444	X	
4	3250	3198	X	
5	3000	2955	X	
6	2750	2708	X	
7	2500	2461	X	
8	2248	2217	X	
9	2000	1974	X	
10	1751	1729	X	
11	1498	1484	X	
12	1300	1285	X	
13	1202	1186	X	
14	1000	989	X	
15	750	741	X	
16	500	496	X	
17	299	295	X	
18	150	149	X	
19	91	89	X	
20	58	58	X	
21	29	33	X	
22				LADCP
23				LADCP
24	4	4	X	

Table 9 – dissolved-Silicon isotopes intercomparison (Niskin cast)

BONUS-GOODHOPE (Marion Dufresne II)
Cast leader: Damien Cardinal
Sampling: François Fripiat & Damien Cardinal

damien.cardinal@africamuseum.be
francois.fripiat@africamuseum.be

LARGE STATION # 7
Station number: 72
Cast number: CTD 99 - L7
Date start (UTC): 14/03/08 **Time start (UTC): 00H10** **Position start (°'): 55.13.930 S / 00.02.660 E**
Date end (UTC): 14/03/08 **Time end (UTC): 01H42** **Position end (°'): 55.13.948 S/ 00.02.611 E**

Bottom depth: 2770m

Niskin	Target depth (m)	Real depth (dbar)	Volume (ml)	NO3/Si
24	surface	4.1	1000	X
20	40	39.1	1000	X
18	80	79.8	1000	X
17	100	100.3	1000	X
13	200	199	1000	X
5	600	599.5	250	X
1	1000	1001.8	250	X

Process: Filtered under pressure through 0.45µm PC membranes (Nuclepore)
Storage: PP bottles, dark, room temperature, not acidified

CARBON DIOXIDE

1. AIR-SEA CO_2 FLUXES and INORGANIC CARBON VERTICAL DISTRIBUTION

Bruno Delille (Bruno.Delille@ulg.ac.be)
Nicolas-Xavier Geilfus (nxgeilfus@ulg.ac.be)
Université de Liège
Departement d'Astrophysique, Geophysique et Océanographie
Unité d'Océanogaphie Chimique
Allée du 6 Août, 17
B-4000 Liège
Belgium

The Southern Ocean (SO) acts as a sink for atmospheric CO_2. Primary production at mid-latitude is one of the main contributors to this uptake of CO_2. However, how air-sea CO_2 fluxes relate ultimately to carbon export is still poorly constrained partly due to the complexity of physical and biogeochemical processes which drive CO_2 fluxes.
Sinking of mid-latitude mode and intermediate waters of SO is a major pathway for anthropogenic CO_2 penetration in the ocean interior. Further south, although deep water formation was initially thought as an efficient mechanism for anthropogenic CO_2 sequestration most data based on model estimates low anthropogenic CO_2 storage. However, recent studies which take into account oxygen disequilibrium under ice suggest that deep and bottom water formation in the SO is still a key process in the natural sequestration of anthropogenic CO_2 and that inventory of anthropogenic CO_2 in the SO could be much larger than what is currently believed and must be revised.

In the frame of the Bonus-Goodhope project we aim to address the following questions:

- How air-sea CO_2 fluxes relate to carbon export assessed from geochemical multi-proxy approach in the biologically active mid-latitude zone of the S.O.?

-What is the inventory of anthropogenic CO_2 along zero meridian if we carefully take into account sea ice cover effect on surface oxygen concentration further south? What is the contribution of mode and intermediate waters subduction to the overall anthropogenic CO_2 penetration.

In order to address these questions, we carried out underway pCO_2 and DIC discrete measurements in order to assess the spatial distribution of the partial pressure of CO_2 (pCO_2) at the surface and the vertical distribution of dissolved inorganic carbon respectively.

Underway pCO_2

Underway measurement of pCO2 concentration of surface waters was carried out throughout the cruise, from 13-02 to 23-03-08.
The complete description and performance test of the system for pCO2 measurements was reported by Frankignoulle et al. (2001). Briefly, pCO_2 was measured continuously from the uncontaminated seawater supply of the ship. A non-dispersive infrared gas analyser (IRGA, Li-Cor® LI-6262) was used to measure pCO_2 in air equilibrated with seawater. The IRGA was calibrated daily using three gas standards of 0, 359.9 and 404.7 ppm provided by Air Liquide Belgium®. Seawater flowed into an equilibrator (3 L min^{-1}) from the top, and a closed air loop (3 L min^{-1}) ensures circulation through the equilibrator (from the bottom to the top) and the IRGA. Temperature at the outlet of the equilibrator was monitored using a pt100 temperature sensor. The

pCO_2 values were corrected for the temperature difference between in situ seawater and water in the equilibrator, using the algorithm proposed by Copin-Montégut (1988; 1989).

In addition, an intercomparison with the group led by N. Metzl from the Laboratoire d'Océanographie et du Climat: Expérimentations et Approches Numériques, Institut Pierre Simon Laplace was carried out in 1998 aboard the R.V. Marion Dufresne. This will ensure a consistent potential merging of pCO_2 data from BGH cruise and OISO (Ocean Indien - Service d'Observation) survey carried out in January 2008 in adjacent waters.

Discrete dissolved inorganic carbon

All 78 "hydro" cast were sampled (all depths) for analysis of Dissolved Inorganic Carbon (DIC) analysis. More than 90% of the samples were analyzed aboard. The rest of the samples will be subsequently analyzed in Belgium.

DIC measurements were carried out with the new AIR-DIC (Analysis InfraRed – Dissolved Inorganic Carbon) system developed by MARIANDA.

The AIR-DIC, automatically acidifies and strips the CO_2 out of a known volume of sea water ranging from 500 µL up to 2000 µL integrating the infra red IR absorbance from CO_2. The AIR-DIC system consists of 4 main components:, a syringe module, a sample stripping manifold, a LICOR LI-6252 non-dispersive CO_2 infra-red analyzer and a personal computer. A Kloehn syringe module equipped with a 5 port distribution valve and a thermostated 2.5 ml syringe are used to select and subsample from either water sample or a certified reference material CRM. The sample is delivered to a glass stripper. The sample is acidified in the stripper with 1.0 ml of 8.5% H_3PO_4 and the CO_2 is stripped from the sample with N_2. The gas from the stripper is dried using a series of two Pemarpure Nafion tubes before measurement of CO_2 concentration by the analyzer.

The mole fraction of the CO_2 is integrated to determine the total CO_2 stripped from the sample. The DIC from a seawater sample of 1500 µL was stripped during 145 s with a flow rate of N_2 of 200 ml min L^{-1}. The average of 4 replicates was considered to compute DIC concentration. The system was calibrated by carrying out measurement of 1450, 1500 and 1600 µL of Certified Reference Materials (CRM) delivered by Andrew Dickson.

Water samples and CRM was kept to a constant temperature prior and during analysis.

This system is a prototype. This cruise was the first opportunity to assess the performance of the system. We carried out an intercomparison with measurements carried out by Melchor Gonzalez Davila and Magdalena Santana-Casiano from the University of Las Palmas in Gran Canarias using the VINDTA colombimetric system, the currently most accurate and precise method for determining DIC in seawater (DOE, 1994).

Preliminary results

During the cruise, pCO_2 ranged from 325 to 415 ppmV, and exhibited significant changes across fronts and eddies than can be tracked as step changes in SST (Figures 9-10). Subtropical area appeared to be undersaturated in CO_2 compared to the atmosphere, while the subantarctic and polar frontal zones were below or near the saturation, and the polar open oceanic zone was oversaturated. The maximum of pCO_2 was observed at the southern circumpolar antarctic front (SACCF).

Comparison with pCO_2 measurement carried out during the ISPOL cruise in spring 2004 and early summer 2004-2005 (data not shown) suggest that pCO_2 was significantly higher during the Bonus-Goodhope cruise south of the subtropical front (STF). This might suggest at first sight that we encountered a late summer regime, with conjugated warming of surface water and remineralisation of organic matters that increase pCO_2 in the subantarctic zone. South of the polar front (PF), upwelling of CO_2 rich subsurface waters (Figure 11) may contribute to the increase of CO_2 and lead to the oversaturation in CO_2 compared to the atmosphere.

Significant increase of DIC over the thousand first meters of the water column is related to mesopelagic biomineralisation. Below 1000 m, main water masses of the subtropical area and circumpolar current (e.g. North Atlantic Deep Water, Circumpolar Deep Water, intermediate antarctic waters, among others) appears in the vertical distribution. For instance, in the suptropical area, a tongue of Antarctic Intermediate Water with DIC ranging between 2210 and 2235 µmol kg^{-1} water is transported northward between 1000 and 1500 m. We observed an overall DIC increases southwards. Between the STF and southern boundary (SBy), DIC increases towards the bottom, while south of the SBy with an increase of DIC distribution exhibited an increase towards the bottom that mimics the increase of oxygen concentration (data not shown). Maximum of DIC was observed south of the SBy in the top 1000 m.

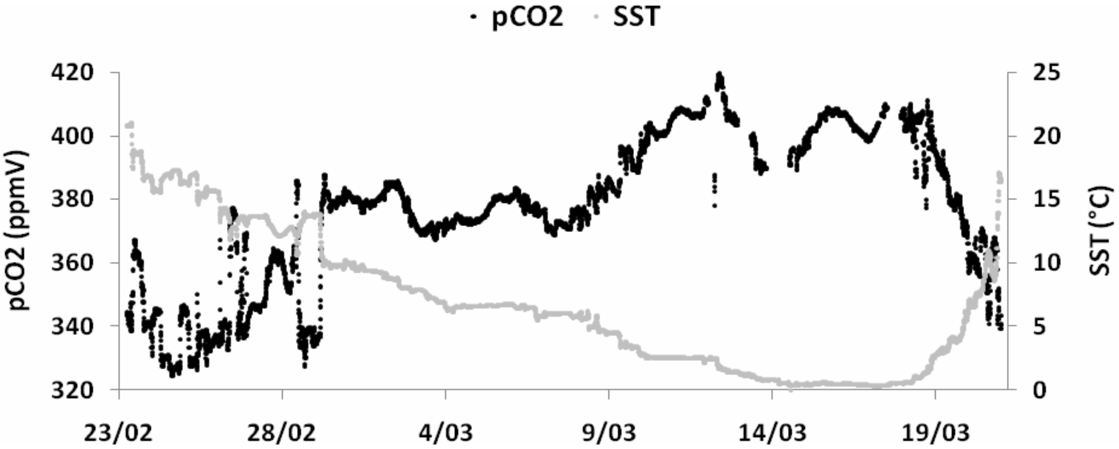

Figure 9- Sea surface temperature (SST) and pCO_2 change along the cruise.

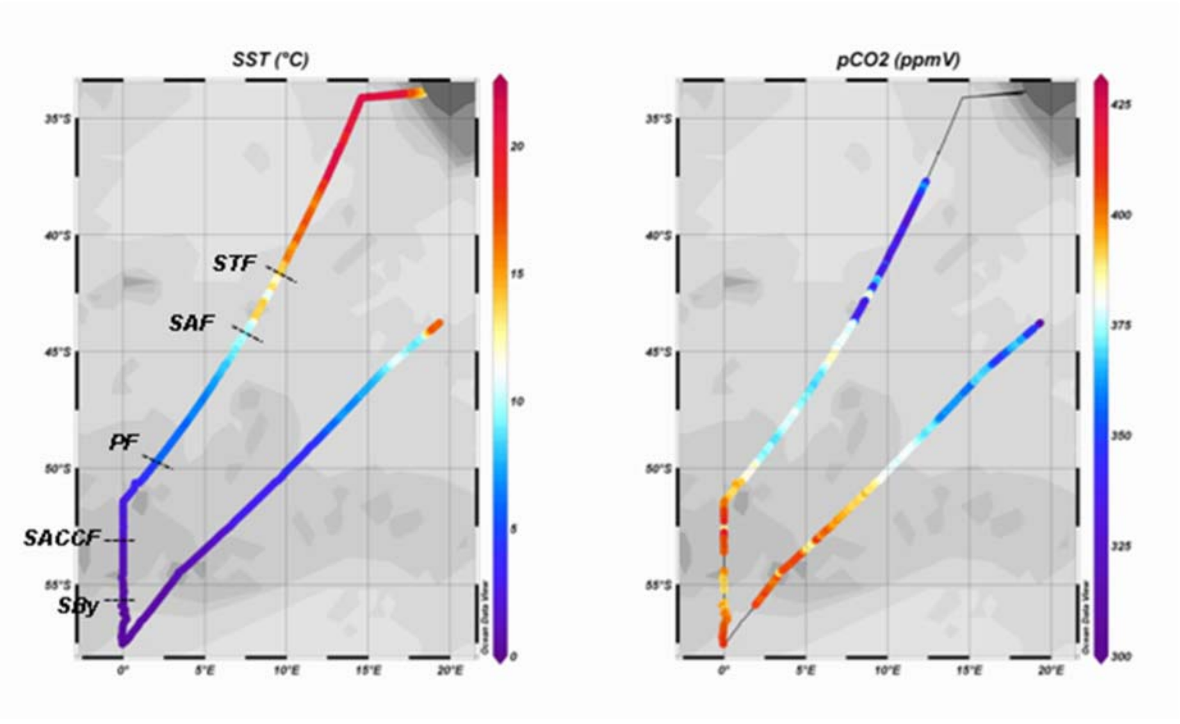

Figure 10- Distribution of sea surface temperature (SST) and pCO_2 along the shiptrack. Approximate position of the subtropical (STF), subantarctic (SAF), polar (PF), southern antarctic circumpolar (SACCF) fronts and southern boundary (SBy) are indicated by the black dotted lines.

Significant increase of DIC over the thousand first meters of the water column is related to mesopelagic biomineralisation. Below 1000 m, main water masses of the subtropical area and circumpolar current (e.g. North Antlantic Deep Water, Circumpolar Deep Water, intermediate antarctic waters, among others) appears in the vertical distribution. For instance, in the suptropical area, a tongue of antarctic intermediate water with DIC ranging between 2210 and 2235 µmol kg^{-1} water is transported northward between 1000 and 1500 m. We observed an overall DIC increases southwards. Between the STF and southern boundary (SBy), DIC increases towards the bottom, while south of the SBy with an increase of DIC distribution exhibited an increase towards the bottom that mimics the increase of oxygen concentration (data not shown). Maximum of DIC was observed south of the SBy in the top 1000 m.

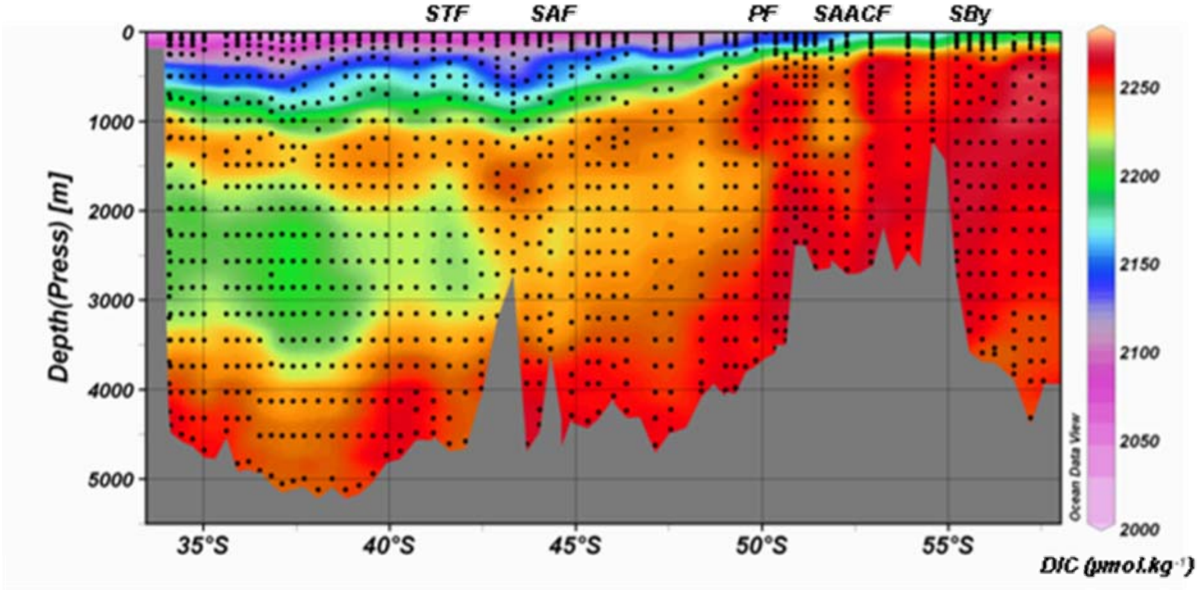

Figure 11- Vertical distribution of dissolved inorganic carbon (DIC) along the BONUS-GOODHOPE transect. Approximate position of the subtropical (STF), subantarctic (SAF), polar (PF), southern antarctic circumpolar (SACCF) fronts and southern boundary (SBy) are indicated.

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2. CARBONATE SYSTEM VARIABLES (pH, Total Alkalinity, DIC)

Prof. Dr. Melchor González-Dávila (mgonzalez@dqui.ulpgc.es)
Prof. Dr. J. Magdalena Santana-Casiano (jmsantana@dqui.ulpgc.es)
University of Las Palmas de Gran Canaria
Faculty of Marine Science
Department of Chemistry
35017 Las Palmas de Gran Canaria
Spain

Scientific Objectives.

- Determine the carbonate system variables in the water column along the BONUS-GOODHOPE section and compare them with data in previous cruises, with special emphasis on the saturation grade for calcite and aragonite.
- Determine the water mass distribution using an optimized multiparameters analysis model (OMP).
- Evaluate the anthropogenic carbon budget along the BONUS-GOODHOPE section : importance of the different water masses, AABW, SAMW and AAIW. Application and comparison of different methodologies to this computation. Relationship with the evolution of other tracers as CFCs.
- Establish the inventory of C_{ANT} transported and stored during 2008. Comparison with data from 2004 of GoodHope cruise.

Scientific and sampling strategies.

Three variables of the carbonate system were measure on board of the Marion Dufresne in order to achieve the highest level of data quality and resolution and to account for the objectives above proposed. Initial invitation to participate in this cruise considered only the determination of two of these variables. However, the QUIMA group of ULPGC owns a coulometric determination system for total dissolved inorganic carbon that was considered by us to be an important contribution to the success of this project. 79 hydrocast Stations (78 stations plus station zero) were sampled for pH in total scale at 25ºC ($pH_{T,25}$), total alkalinity (TA, in μmol kg^{-1}) and total dissolved inorganic carbon (CT, in μmol kg^{-1}). From a total of about 1639 fired bottles in hydrocast CTD stations at not repeated depths and after the corresponding analysis of the total amount of samples on board, considering in some cases a selection of depths of sampling and time for the analysis by two people, broken samples, flagged data, and other small problems, a total of valid results for pH data of 1609, for TA of 1559 and for CT of 1504 have been obtained.

Protocols.

Parameter definition and methodology

pH

The pH is measured in total scale ($[H^+]_T = [H^+]_F + [HSO_4^-]$, where $[H^+]_F$ is the free proton concentration), pH_T at a constant temperature of 25ºC. An automatized system based on the spectrophotometric technique of *Clayton and Byrne* [1993] with the m-cresol purple as indicator was used [*González-Dávila et al.*, 2003].

Total Alkalinity

Samples for A_T were potentiometrically titrated with standarized 0.25 M HCl (0.45M in NaCl) to the carbonic acid end point using a systems described in detail by *Mintrop et al.* [2000]. The titration of certify reference

Material for Oceanic CO_2, CRMs (#85) was used to test the performance of the titration system given values that were within ± 1.0 µmol kg^{-1} of the certified value.

Total Dissolved Inorganic Carbon

A VINDTA 3C system [*Mintrop et al.*, 2000] (www.MARIANDA.com), with coulometer determination was used for the titration of the total dissolved inorganic carbon after phosphoric acid addition. The titration of CRMs (#85) was used to test the performance of the equipment after the preparation of each titration cell. Over 30 bottles were analysed on board with a system precision of ± 1.5 µmol kg^{-1}.

Sampling procedure

500 ml glass bottles were used for the determination of both pH and TA. 100 ml glass bottles were used to analyse CT. The bottles were rinsed twice with seawater and over-filled with seawater. Samples were preserved from the light and analysed between stations. In shallow stations and in case the samples were not possible to be analysed for CT in less than 5 hours after sampling, poisoned with $HgCl_2$ (60 µl, saturated solution) was used.

Preliminary results.

Most of the effort we have carried out during transit days from the last station to Durban has been to process a first quality control to our data checking the CRMs reproducibility and accuracy.

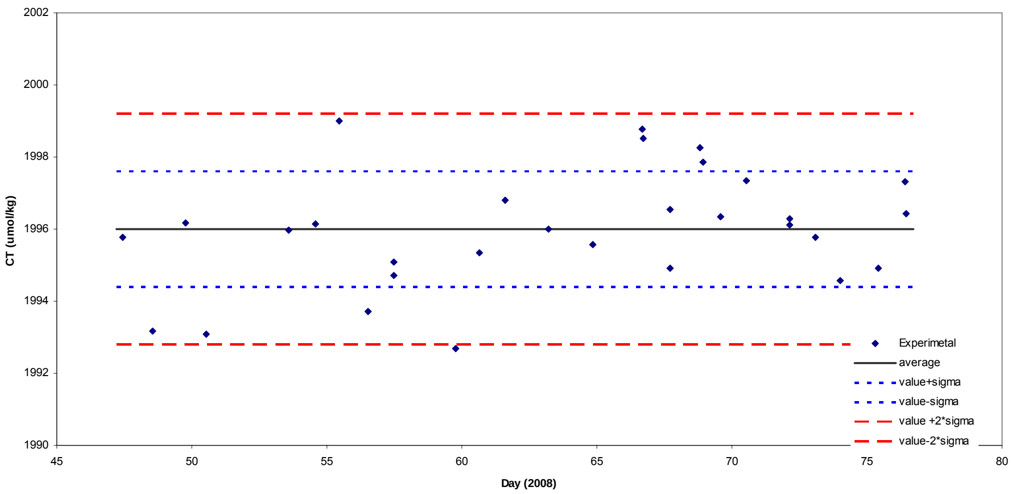

Fig. 12- Chart sheet with values of CT for the CRMs #85 determined in the cruise.

A CRM was analysed every time a new titration cell for CT determination was prepared (1 a day, except in Super stations) with a total of 31 data. Results give a value of 1996.0 ± 1.6 µmol kg^{-1} for CT, while the certify value is 2000.4 ± 0.4 µmol kg^{-1}. A study done on board indicates that this difference is related to the temperature of determination of the CT that in our case was 25° C. Data has been corrected for this shift multiplying them by the factor 1.0022.

Each CRM sample was also analysed for total alkalinity determination, and the corresponding chart sheet is presented in Fig. 13. The agreement between on board experimental data (NAT = 2293.7 ± 1.0) and certify value (NAT = 2293.7 ± 0.8) indicates accurate HCl concentration and pipette volume for the titration system.

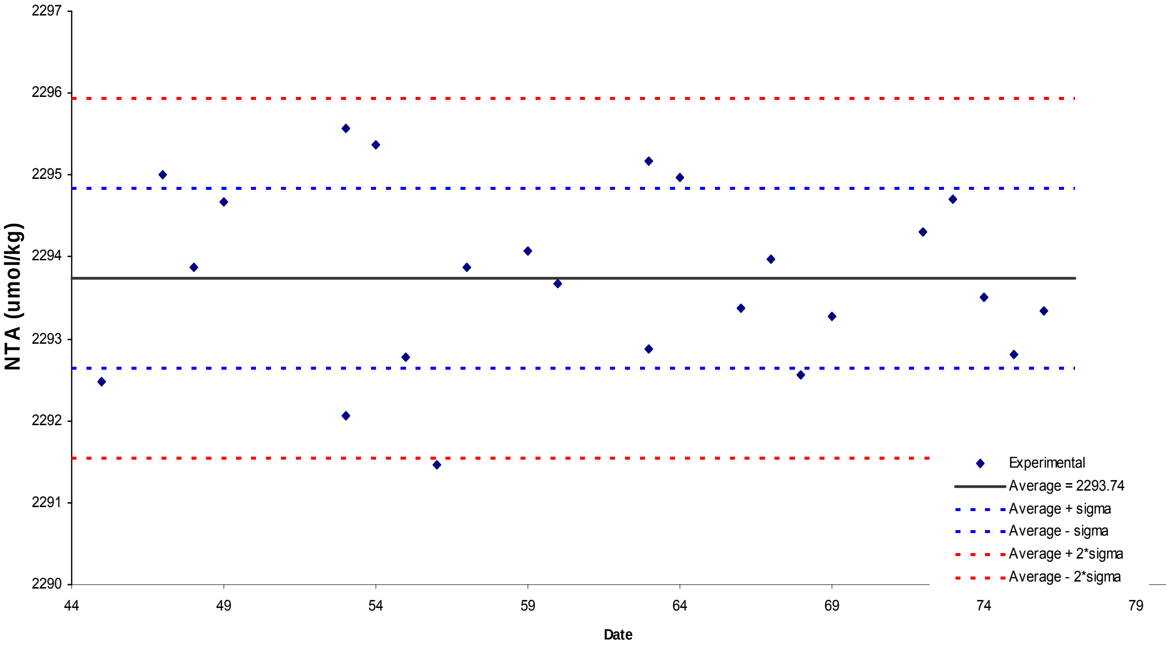

Fig. 13- Chart sheet with values of TA (µmol kg^{-1}) for CRM batch #85 analysed on board.

The inorganic carbon system determination requires salinity values for the samples analysed in order to compute the corresponding concentration both for Total alkalinity and CT. Moreover, the spectrophotometric determination of pH needs also the salinity value for the determination of the acidity constant of the dye, which is salinity dependent. The area studied along this cruise cross important frontal zones, eddies and meanders which will affect the carbonate distribution strongly correlated with water mass properties, in particular with salinity values. At this moment, we have been able to used salinity values for each bottle fired on the CTD cast, that are not validated. We expect that after real values are provided, in four weeks we can be able to provide data for each analysed parameter and an analysis of results. Same preliminary results for pH_T at 25ºC are presented in Figure 14, where the stations have been selected just before and after the frontal zone STF, SAF, PF, SACCF and SBdy. Changes in the vertical profiles are related to changes in seawater properties of the different water masses and frontal zones. Station 36, shows the effect of the anticyclone Ed. Michel which affects the surface pH distribution in the first 600 meters acting as important carbon pump. Moreover, Fig. 15, presents the preliminary results for the total Alkalinity along the 79 stations, closely linked to salinity variability, where the presence of the different water masses, the frontal zone and mesoscale structures are observed.

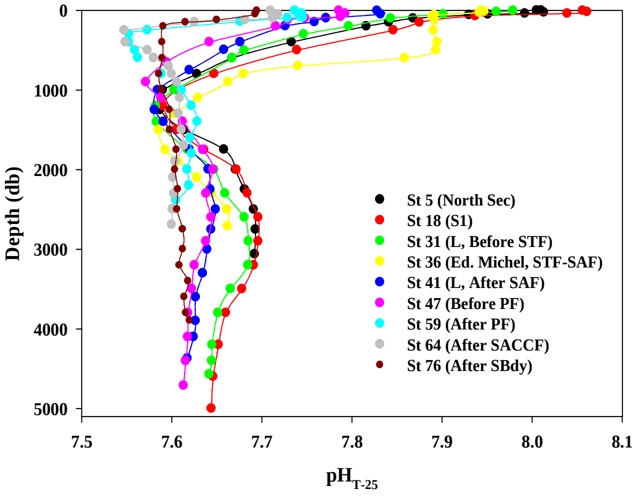

Fig. 14- Vertical profiles of pH in total scale at 25ºC for selected stations representative for each area along the BONUS-GOODHOPE section.

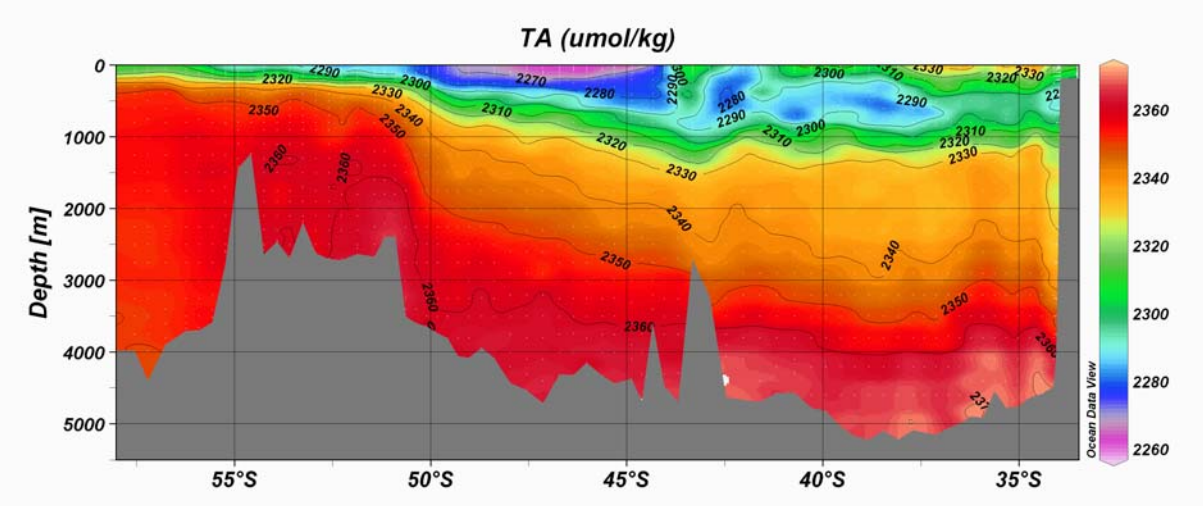

Fig. 15- Total alkalinity (in µmol kg-1) distribution along the BONUS-GOODHOPE section

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3. INTERCOMPARISON OF CARBONDIOXIDE VARIABLES with the German *R.V. Polarstern*

Written by Marie BOYE (marie.boye@univ-brest.fr)

Onboard Marion Dufresne: Bruno Delille, Nicolas-Xavier Geilfus, Melchor González-Dávila, Magdalena Santana-Casiano
Onboard Polarstern: Steven van Heuven, Hans Slagter, Hein de Baar

For the sections from Capetown to the zero meridian, and from there along zero meridian to Antarctica, the GEOTRACES-CASO program of BONUS-GOODHOPE program (MD166) aboard Marion Dufresne is complementary to the Polarstern ANT XXIV-3. Towards an overall integrated database of both expeditions, some intercomparison of carbondioxide variables between both programs was envisioned.

The initial cruise tracks of Marion Dufresne and Polarstern were scheduled to be overlapping, and this, in principle, allows the positioning of stations and sampling depths at the same place. This is the strategy of choice for intercomparison of CO_2 system measurements, which are already calibrated routinely on both ships, by the shipboard use of certified reference material (CRM, supplied by Dr. A. Dickson, Scripps Institute of Oceanography).

Once at sea, Polarstern by its earlier departure was further south than Marion Dufresne. At 26 February the positions and sampling depth horizons (pressure, salinity, temperature at 22-24 depths per station) of thus far completed 21 stations with CO_2 system data aboard Polarstern (then until 59^{o}S, 0^{o}W) were communicated to Marion Dufresne. This allows re-occupation of selected same stations by BONUS-GOODHOPE, its overall research program and the weather permitting. 10 duplicated stations nearly matched the same occupation of both ships within 5 nautical miles maximal difference were sampled on both cruises of 22 depths each (Table 10). These common stations were located between 46°02.41'S, 5°86.48' E and 57°55.25' S, 0°03.65' E (Tables 10-11).

Table 10 – Carbondioxide variables intercomparison between Marion-Dufresne (BONUS-GOODHOPE) and Polarstern (ANT XXIV-3).

Dissolved Inorganic Carbon (DIC)	INFRARED DETECTOR SYSTEM (CT Infr), RESPONSIBLE: BRUNO DELILLE, ULg, BELGIUM, Bruno.Delille@ulg.ac.be
Dissolved Inorganic Carbon (DIC)	COULOMBIMETRIC SYSTEM (CT Coul), RESPONSIBLE: MELCHOR GONZALEZ DAVILA, ULPGC, SPAIN, mgonzalez@dqui.ulpgc.es
Total Alkalinity (TA)	POTENTIOMETRIC SYSTEM, RESPONSIBLE: J. MAGDALENA SANTANA-CASIANO, ULPGC, SPAIN, jmsantana@dqui.ulpgc.es

POLARSTERN				MARION DUFRESNE				
Cruise	Station	Lat [¼N]	Lon [¼E]	Lat, ¼N	Lon, ¼E	Difference in nm	CTD cast	Station
PS71	101	-42,3379	8,9946					
PS71	102	-44,6604	7,0954					
PS71	103	-45,9999	5,8811	-46,024167	5,86483333	1,606051634	CTD 57	St 44
PS71	104	-47,6635	4,2887	-47,554167	4,37516667	7,434207156	CTD 63	St 48
PS71	106	-48,9116	2,8003	-48,701167	3,17818333	19,55498367	CTD 69	St 51
PS71	107	-50,2742	1,4531	-50,372667	1,30216667	8,266440325	CTD 77	St 57
PS71	108	-51,4983	0,0028	-51,431	0,009	4,04464515	CTD 82	St 61
PS71	110	-51,9454	0,0126	-51,867	0,006	4,710340178	CTD 84	St 62
PS71	112	-52,5049	-1,3844	-52,601333	0,0015	50,88976205	CTD 89	St 64
PS71	113	-52,9968	0,0288	-52,930367	-0,0003167	4,122552811	CTD 90	St 65
PS71	115	-53,5184	0,0043	-53,591917	-0,0002667	4,414002136	CTD 93	St 67
PS71	116	-54,0002	-0,0001	-53,918833	0,00166667	4,882398334	CTD 94	St 68
PS71	118	-54,5041	0,0354	-54,580467	-0,0007	4,751159707	CTD 96	St 70
PS71	119	-55,0009	0,0011	-54,912667	-0,0048333	5,297944953	CTD 97	St 71
PS71	121	-55,4969	0,0002	-55,570317	0,00456667	4,407494698	CTD 101	St 73
PS71	122	-56,0048	0,0088	-55,904267	-0,1138333	7,30440427	CTD102	St 74
PS71	124	-56,5057	0,0149	-56,762267	-0,0142167	15,42395604	CTD 104	St 76
PS71	127	-57,4995	0,0132	-57,5525	-0,0365	3,560319702	CTD 106	St 78
PS71	128	-58,0037	-0,0012					
PS71	130	-58,4992	0,0035					
PS71	131	-59,0002	0,0064					

In black, Stations located inside 5 nm to be considered in this study

Table 11 – Additional informations on CO2 variables onboard Marion-Dufresne used for the intercomparison, including depths where data are available.

	CTD Cast	Niskin	Depth(db)	T (¼C)	Salinity	CT Infr	CT Coul	TA
BGH-2008	57	1	4147,9	0,817	34,69	x	x	x
BGH-2008	57	2	3802,4	0,954	34,703	x	x	x
BGH-2008	57	3	3501,9	1,155	34,716	x	x	x
BGH-2008	57	4	3252,4	1,298	34,725	x	x	x
BGH-2008	57	5	3000,9	1,468	34,737	x	x	x
BGH-2008	57	6	2749,8	1,662	34,748	x	x	x
BGH-2008	57	7	2497,4	1,902	34,763	x	x	x
BGH-2008	57	8	2248,8	2,116	34,766	x	x	x
BGH-2008	57	9	1999,4	2,374	34,771	x	x	
BGH-2008	57	10	1749,4	2,548	34,743	x	x	x
BGH-2008	57	11	1501,9	2,571	34,685	x	x	x
BGH-2008	57	12	1298,8	2,588	34,623	x	x	x
BGH-2008	57	13	1200,3	2,592	34,58	x	x	x
BGH-2008	57	14	1001,2	2,618	34,479	x	x	x
BGH-2008	57	15	749,3	2,781	34,325	x	x	x
BGH-2008	57	16	500,7	3,136	34,173	x	x	x
BGH-2008	57	17	299,6	3,986	34,123	x	x	x
BGH-2008	57	18	151,1	4,987	34,055	x	x	x
BGH-2008	57	19	90,4	5,811	33,949	x	x	x
BGH-2008	57	20	61	7,864	33,734	x		x
BGH-2008	57	21	32,2	7,863	33,735	x		x
BGH-2008	57	24	4,7	7,861	33,734	x	x	x
BGH-2008	82	1	2666,5	0,487	34,673	x	x	x
BGH-2008	82	2	2499,9	0,543	34,676	x	x	x
BGH-2008	82	3	2250,4	0,672	34,683	x	x	x
BGH-2008	82	4	1999,9	0,853	34,693	x	x	x
BGH-2008	82	5	1798,4	1,028	34,703	x	x	x
BGH-2008	82	6	1597	1,177	34,703	x	x	x
BGH-2008	82	7	1399	1,39	34,711	x	x	x
BGH-2008	82	8	1200	1,645	34,725	x	x	x
BGH-2008	82	9	1000,2	1,818	34,719	x	x	x
BGH-2008	82	10	796,5	1,985	34,697	x	x	x
BGH-2008	82	11	795,4	1,982	34,696			
BGH-2008	82	12	794,5	1,982	34,696			
BGH-2008	82	13	597,3	2,023	34,641	x	x	x
BGH-2008	82	14	499,5	2,043	34,59	x	x	x
BGH-2008	82	15	399	2,039	34,534			x
BGH-2008	82	16	247,8	1,742	34,354	x	x	x
BGH-2008	82	17	139,9	1,257	33,852	x	x	x
BGH-2008	82	18	121,2	1,851	33,773	x	x	x
BGH-2008	82	19	100,3	2,408	33,716	x	x	x
BGH-2008	82	20	69,3	2,744	33,713	x	x	x
BGH-2008	82	21	27,9	2,776	33,713	x	x	x
BGH-2008	82	24	4,6	2,78	33,713	x	x	

	CTD Cast	Niskin	Depth(db)	T (¼C)	Salinity	CT Infr	CT Coul	TA
BGH-2008	84	1	2551	0,465	34,673	x	x	x
BGH-2008	84	2	2503	0,471	34,673	x	x	x
BGH-2008	84	3	2500,2	0,47	34,673			
BGH-2008	84	4	2300,8	0,538	34,677	x	x	x
BGH-2008	84	5	2300,5	0,538	34,677			
BGH-2008	84	6	2101,2	0,657	34,682	x	x	x
BGH-2008	84	7	2102	0,657	34,682			
BGH-2008	84	8	2000,5	0,693	34,684	x	x	x
BGH-2008	84	9	1800,8	0,804	34,688	x	x	x
BGH-2008	84	10	1601,1	0,983	34,697	x	x	x
BGH-2008	84	11	1395,6	1,161	34,704	x	x	x
BGH-2008	84	12	1201,3	1,37	34,711	x	x	x
BGH-2008	84	13	1001,1	1,559	34,712	x	x	x
BGH-2008	84	14	798,1	1,734	34,699	x	x	x
BGH-2008	84	15	597,7	1,85	34,659	x	x	x
BGH-2008	84	16	401,1	1,87	34,558	x	x	x
BGH-2008	84	17	299,7	1,746	34,489	x	x	x
BGH-2008	84	18	200,4	1,188	34,26	x	x	x
BGH-2008	84	19	150,9	0,805	34,005	x	x	x
BGH-2008	84	20	99,6	2,043	33,739	x	x	x
BGH-2008	84	21	49	2,533	33,698	x	x	x
BGH-2008	84	24	4,9	2,528	33,698	x	x	x
BGH-2008	90	1	2612,1	0,415	34,669	x	x	x
BGH-2008	90	2	2499,8	0,423	34,67	x	x	x
BGH-2008	90	3	2301,4	0,454	34,672	x	x	x
BGH-2008	90	4	2098,4	0,482	34,674	x	x	x
BGH-2008	90	5	1899,4	0,528	34,675	x	x	x
BGH-2008	90	6	1747,4	0,634	34,68	x	x	x
BGH-2008	90	7	1500,3	0,872	34,694	x	x	x
BGH-2008	90	8	1298,7	1,057	34,701	x	x	x
BGH-2008	90	9	1099,9	1,236	34,707			
BGH-2008	90	10	899,3	1,423	34,705	x	x	x
BGH-2008	90	11	798,7	1,596	34,709	x	x	x
BGH-2008	90	12	699,7	1,714	34,704	x	x	x
BGH-2008	90	13	597,9	1,691	34,683	x	x	x
BGH-2008	90	14	499,5	1,765	34,66	x	x	x
BGH-2008	90	15	398,6	1,824	34,629	x	x	x
BGH-2008	90	16	249,3	1,713	34,52	x	x	x
BGH-2008	90	17	179,2	1,174	34,332	x	x	x
BGH-2008	90	18	136,9	0,592	33,997	x	x	x
BGH-2008	90	19	108,2	1,249	33,798	x	x	x
BGH-2008	90	20	67,7	1,653	33,749	x	x	
BGH-2008	90	21	30,2	1,73	33,744	x	x	x
BGH-2008	90	24	3,9	1,749	33,742	x	x	
BGH-2008	93	1	2664,9	0,365	34,667	to be processed	x	x
BGH-2008	93	2	2500,6	0,372	34,668	to be processed	x	x
BGH-2008	93	3	2301,8	0,393	34,669	to be processed	x	
BGH-2008	93	4	2101,5	0,433	34,671	to be processed	x	x
BGH-2008	93	5	1899,7	0,482	34,673	to be processed	x	x
BGH-2008	93	6	1751,7	0,554	34,676	to be processed	x	x
BGH-2008	93	7	1500,3	0,707	34,681	to be processed	x	x
BGH-2008	93	8	1299,7	0,857	34,687	to be processed	x	x
BGH-2008	93	9	1100,9	1,049	34,692	to be processed	x	x
BGH-2008	93	10	902,9	1,27	34,697	to be processed	x	x
BGH-2008	93	11	800,8	1,349	34,698	to be processed	x	x
BGH-2008	93	12	701,5	1,43	34,694	to be processed	x	x
BGH-2008	93	13	601,3	1,522	34,687	to be processed	x	x
BGH-2008	93	14	499,1	1,601	34,672	to be processed	x	x
BGH-2008	93	15	400,6	1,651	34,645	to be processed	x	x
BGH-2008	93	16	251,6	1,508	34,549	to be processed	x	x
BGH-2008	93	17	169,3	0,934	34,361	to be processed	x	x
BGH-2008	93	18	141,7	0,405	34,157	to be processed	x	x
BGH-2008	93	19	121,6	0,517	33,945	to be processed	x	x
BGH-2008	93	20	79,6	1,395	33,797	to be processed	x	x
BGH-2008	93	21	39,4	1,393	33,798	to be processed	x	x
BGH-2008	93	24	4,3	1,39	33,798	to be processed	x	x
BGH-2008	94	1	2443,6	0,38	34,668	x		x
BGH-2008	94	2	2447,1	0,381	34,668	x	x	x
BGH-2008	94	3	2299,2	0,38	34,668	x		x
BGH-2008	94	4	2100,6	0,411	34,67	x	x	x
BGH-2008	94	5	1899,1	0,475	34,672	x		x
BGH-2008	94	6	1750,1	0,516	34,673	x	x	x
BGH-2008	94	7	1499,1	0,675	34,678	x		x
BGH-2008	94	8	1298,4	0,833	34,683	x	x	x
BGH-2008	94	9	1098,6	1,009	34,69	x		x
BGH-2008	94	10	900,5	1,253	34,696	x	x	x
BGH-2008	94	11	799,7	1,367	34,697	x		x
BGH-2008	94	12	699,6	1,489	34,693	x	x	x
BGH-2008	94	13	599,9	1,563	34,685	x		x
BGH-2008	94	14	500,3	1,636	34,67	x	x	x
BGH-2008	94	15	350	1,671	34,614	x		x
BGH-2008	94	16	251,8	1,622	34,561	x	x	x
BGH-2008	94	17	167,3	0,728	34,243	x		x
BGH-2008	94	18	149,9	0,535	34,273	x	x	x
BGH-2008	94	19	125,5	0,426	34,109	x		x
BGH-2008	94	20	88,7	1,194	33,821	x	x	x
BGH-2008	94	21	49,4	1,198	33,828	x		x
BGH-2008	94	24	3,2	1,198	33,83	x	x	x

	CTD Cast	Niskin	Depth(db)	T (¼C)	Salinity	CT Infr	CT Coul	TA
BGH-2008	96	1	1227,9	1,124	34,69	x	x	x
BGH-2008	96	2	1230,7	1,122	34,69			
BGH-2008	96	3	1100,9	1,216	34,693	x		
BGH-2008	96	4	1102	1,216	34,693			
BGH-2008	96	5	998,9	1,298	34,693	x		x
BGH-2008	96	6	901,1	1,387	34,693	x		
BGH-2008	96	7	800,4	1,497	34,691	x		x
BGH-2008	96	8	699,2	1,567	34,689	x		
BGH-2008	96	9	599,2	1,655	34,678	x	x	x
BGH-2008	96	10	500,5	1,733	34,657	x		
BGH-2008	96	11	397,1	1,665	34,603	x		x
BGH-2008	96	12	298,6	1,65	34,545	x		
BGH-2008	96	13	250,4	1,576	34,489	x		
BGH-2008	96	14	179,8	0,777	34,273	x	x	x
BGH-2008	96	15	139,2	0,421	34,11	x		
BGH-2008	96	16	110	0,999	33,799	x		
BGH-2008	96	17	80,5	1,018	33,791	x		x
BGH-2008	96	18	41	1,017	33,791	x		
BGH-2008	96	19	5,3	1,016	33,791	x	x	x
BGH-2008	97	1	1408,9	0,844	34,683		x	x
BGH-2008	97	2	1299,1	0,924	34,686	x	x	x
BGH-2008	97	3	1090,5	1,109	34,692		x	x
BGH-2008	97	4	999,4	1,216	34,695		x	x
BGH-2008	97	5	1000	1,219	34,695	x	x	x
BGH-2008	97	6	898,8	1,334	34,698	x		x
BGH-2008	97	7	799,5	1,417	34,698	x	x	x
BGH-2008	97	8	697,3	1,501	34,693	x	x	x
BGH-2008	97	9	600,1	1,584	34,684	x	x	x
BGH-2008	97	10	500	1,675	34,67	x	x	x
BGH-2008	97	11	399,6	1,724	34,641	x	x	x
BGH-2008	97	12	330,1	1,72	34,612	x	x	x
BGH-2008	97	13	248	1,656	34,548	x	x	x
BGH-2008	97	14	179,5	1,244	34,416	x	x	x
BGH-2008	97	15	151	0,642	34,225	x	x	x
BGH-2008	97	16	110,3	0,842	33,769	x	x	x
BGH-2008	97	17	78,6	0,869	33,761	x	x	x
BGH-2008	97	18	50	0,871	33,76	x	x	x
BGH-2008	97	19	5,8	0,875	33,76	x		x
BGH-2008	101	1	3511,1	-0,157	34,646	x	x	x
BGH-2008	101	2	3511,9	-0,157	34,646			
BGH-2008	101	3	3399	-0,128	34,647	x	x	x
BGH-2008	101	4	3399,2	-0,128	34,647			
BGH-2008	101	5	3196	-0,09	34,649	x	x	x
BGH-2008	101	6	2999,9	-0,065	34,65	x	x	x
BGH-2008	101	7	2748,5	0,039	34,654	x	x	x
BGH-2008	101	8	2499,3	0,112	34,657	x	x	x
BGH-2008	101	9	2248,5	0,213	34,661	x	x	x
BGH-2008	101	10	1998,8	0,315	34,665	x	x	x
BGH-2008	101	11	1748,6	0,433	34,669	x	x	x
BGH-2008	101	12	1499,6	0,564	34,672	x	x	x
BGH-2008	101	13	1249,5	0,733	34,678	x	x	x
BGH-2008	101	14	999,5	0,994	34,689	x	x	x
BGH-2008	101	15	796,4	1,194	34,687	x	x	x
BGH-2008	101	16	599,5	1,464	34,683	x	x	x
BGH-2008	101	17	399	1,592	34,64	x	x	x
BGH-2008	101	18	198,7	1,586	34,534	x	x	x
BGH-2008	101	19	149,6	1,192	34,405	x	x	x
BGH-2008	101	20	98,6	0,269	34,098	x	x	x
BGH-2008	101	21	49,6	0,467	33,854	x	x	x
BGH-2008	101	24	5,2	0,529	33,836	x	x	x
BGH-2008	106	1	3979,1	-0,371	34,637	x	x	x
BGH-2008	106	2	3749,5	-0,38	34,638	x	x	x
BGH-2008	106	3	3498,7	-0,361	34,639	x	x	x
BGH-2008	106	4	3249,3	-0,318	34,642	x	x	x
BGH-2008	106	5	2999,5	-0,283	34,643	x	x	x
BGH-2008	106	6	2751	-0,25	34,645	x	x	x
BGH-2008	106	7	2500,1	-0,208	34,646	x	x	x
BGH-2008	106	8	2249,2	-0,15	34,649	x	x	x
BGH-2008	106	9	1999	-0,078	34,651	x	x	x
BGH-2008	106	10	1749,1	-0,001	34,654	x	x	x
BGH-2008	106	11	1499,4	0,083	34,658	x	x	x
BGH-2008	106	12	1248,3	0,195	34,662	x	x	x
BGH-2008	106	13	999,7	0,314	34,666	x	x	x
BGH-2008	106	14	800,9	0,401	34,67	x	x	x
BGH-2008	106	15	597,5	0,494	34,671	x	x	x
BGH-2008	106	16	397,5	0,54	34,661	x	x	x
BGH-2008	106	17	299,4	0,439	34,633	x	x	x
BGH-2008	106	18	198,9	-0,258	34,512	x	x	x
BGH-2008	106	19	129,1	-0,664	34,304	x	x	x
BGH-2008	106	20	80,1	0,38	34,133	x	x	x
BGH-2008	106	21	49,5	0,4	34,078	x	x	x
BGH-2008	106	24	4,4	0,402	34,064	x	x	x

BIOGEOCHEMICAL PARAMETERS

1. MACRO-NUTRIENTS

Annick Masson (Annick.Masson@univ-brest.fr)
Frédéric Le Moigne (fred.le.moigne@wanadoo.fr)
Marie Boye (marie.boye@univ-brest.fr)
Laboratoire des Sciences de l’Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Motivation and general sampling strategy for BGH

The BONUS-GOODHOPE from Cape Town to the Southern Boundary of the ACC along the Greenwich Meridian has been chosen because it crosses several oceanographic provinces, and the geographical region where water masses of the ACC and the Agulhas Current converge and mixed before entering the South Atlantic as thermocline waters.

The general sampling strategy consists of monitoring the different waters masses to provide a 2D matrix, vertical and horizontal, of water-mass characteristics to allow understanding of the physical and biogeochemical dynamics along the section with relatively high spatial resolution. The selected vertical scales various water-masses (notably AAIW and SAMW), and the applied horizontal resolution covers the main frontal systems and inter-frontal regions.

Scientific motivation

Nutrients (silicates, nitrates, phosphates) and ammonium are regular parameters in oceanography. Nutrients can be used as physical tracers as well as an indicator of biological production state. The studied area showed typical features about nutrients. Nutrients meridional gradients are expected (Cardinal *et al*, 2006). Moreover meridional nutrients transport is known. Indeed, Subantarctic Mode Waters (SAMW) have been identified as a main conduct of nutrients from the Southern Ocean to low latitudes (Sarmiento *et al*, 2004). So, the question is what are the water masses nutrients properties, how is characterized the meridional nutrient distribution in relationship with phytoplankton community structure, shifts occurring in the Atlantic sector of Southern Ocean and what are the Mode and Intermediate waters nutrients properties?

Nutrient sampling

Silicates, nitrates, phosphates and ammonium samples on each CTD are summarized in the here below spreadsheet (tab 12). Silicates, nitrates and phosphates samples from trace metals incubations were analysed, as well as silicates and nitrates on GO-FLO casts and pores waters from coring samples.

Tab 12- nutrients sampling on all CTD cast

Station N°	Position Longitude ° Est	Latitude ° Sud	CTD number	Station-type	Analysed parameters
1	17,23	-33,98	1	0-fond	-
2	17,96	-33,94	2	0-fond	-
3	17,52	-33,96	3	0-fond	-
4	17,30	-33,98	4	0-fond	-
5	16,95	-33,99	5	0-fond	-
6	16,59	-34,01	6	0-fond	-
7	16,20	-34,03	7	0-fond	-
8	15,69	-34,06	8	0-fond	-
9	15,16	-34,09	9	0-fond	Si(OH)4, NO3-, PO4
10	14,58	-34,12	10	0-fond	Si(OH)4, NO3-, PO4
Large 1	14,41	-34,43	11	0-fond	Si(OH)4, NO3-, PO4
Large 1	14,41	-34,43	12	CM	Si(OH)4, NO3-, PO4, NH4
12	14,22	-34,72	13	0-fond	Si(OH)4, NO3-, PO4
13	14,05	-35,03	14	0-fond	Si(OH)4, NO3-, PO4
14	13,87	-35,33	15	0-fond	Si(OH)4, NO3-, PO4
15	13,68	-35,63	16	0-fond	Si(OH)4, NO3-, PO4
16	13,50	-35,92	17	0-fond	Si(OH)4, NO3-, PO4
17	13,32	-36,22	18	0-fond	Si(OH)4, NO3-, PO4
Super 1	13,12	-36,52	19	0-fond	Si(OH)4, NO3-, PO4
Super 1	13,12	-36,52	20	CM	Si(OH)4, NO3-, PO4, NH4
Super 1	13,12	-36,52	21	REE	-
Super 1	13,12	-36,52	22	PoTh	Si(OH)4, NO3-
Super 1	13,12	-36,52	23	BaSi	Si(OH)4, NO3-
19	12,93	-36,80	24	0-fond	Si(OH)4, NO3-, PO4
20	12,74	-37,12	25	0-fond	Si(OH)4, NO3-, PO4
21	12,55	-37,42	26	0-fond	Si(OH)4, NO3-, PO4
22	12,35	-37,70	27	0-fond	Si(OH)4, NO3-, PO4
23	12,08	-38,08	28	0-fond	Si(OH)4, NO3-, PO4
24	11,83	-38,46	29	0-fond	Si(OH)4, NO3-, PO4
25	11,58	-38,83	30	0-fond	Si(OH)4, NO3-, PO4
26	11,32	-39,19	31	0-fond	Si(OH)4, NO3-, PO4
27	11,05	-39,55	32	0-fond	Si(OH)4, NO3-, PO4
28	10,81	-39,93	33	0-fond	Si(OH)4, NO3-, PO4
29	10,55	-40,29	34	0-fond	Si(OH)4, NO3-, PO4
30	10,20	-40,72	35	0-fond	Si(OH)4, NO3-, PO4
Large 2	9,92	-41,19	37	0-fond	Si(OH)4, NO3-, PO4
Large 2	9,92	-41,19	38	CM	Si(OH)4, NO3-, PO4, NH4
32	9,58	-41,61	39	0-fond	Si(OH)4, NO3-, PO4
33	9,27	-42,03	40	0-fond	Si(OH)4, NO3-, PO4
Super 2	8,93	-42,47	41	0-fond	Si(OH)4, NO3-, PO4
Super 2	8,93	-42,47	42	REE	-
Super 2	8,93	-42,47	43	PoTh	Si(OH)4, NO3-
Super 2	8,93	-42,47	44	BaSi	Si(OH)4, NO3-
Super 2	8,93	-42,47	45	CM	Si(OH)4, NO3-, PO4, NH4
35	8,56	-42,89	46	0-fond	Si(OH)4, NO3-, PO4
36	8,24	-43,33	47	0-fond	Si(OH)4, NO3-, PO4
37	7,98	-43,69	48	0-fond	Si(OH)4, NO3-, PO4
38	7,63	-44,04	49	0-fond	Si(OH)4, NO3-, PO4

39	7,38	-44,34	50	0-fond	Si(OH)4, NO3-, PO4
40	7,15	-44,61	51	0-fond	Si(OH)4, NO3-, PO4
Large 3	6,90	-44,88	52	0-fond	Si(OH)4, NO3-, PO4
Large 3	6,90	-44,88	53	CM	Si(OH)4, NO3-, PO4, NH4
Large 3	6,90	-44,88	54	PoTh	Si(OH)4, NO3-
42	6,52	-45,32	55	0-fond	Si(OH)4, NO3-, PO4
43	6,23	-45,61	56	0-fond	Si(OH)4, NO3-, PO4
Large 4	5,87	-46,03	57	0-fond	Si(OH)4, NO3-, PO4
Large 4	5,87	-46,03	58	CM	Si(OH)4, NO3-, PO4, NH4
45	5,53	-46,35	59	0-fond	Si(OH)4, NO3-, PO4
46	5,20	-46,72	60	0-fond	Si(OH)4, NO3-, PO4
47	4,79	-47,14	61	0-fond	Si(OH)4, NO3-
Super 3	4,38	-47,55	62	0-fond	Si(OH)4, NO3-, PO4
Super 3	4,38	-47,55	63	0-fond	Si(OH)4, NO3-, PO4
Super 3	4,38	-47,55	64	REE	-
Super 3	4,38	-47,55	65	PoTh	Si(OH)4, NO3-
Super 3	4,38	-47,55	66	BaSi	Si(OH)4, NO3-
49	3,96	-47,97	67	0-fond	Si(OH)4, NO3-, PO4
50	3,18	-48,70	68	0-fond	Si(OH)4, NO3-, PO4
51	3,52	-48,38	69	0-fond	Si(OH)4, NO3-, PO4
Large 4	2,83	-49,03	70	0-fond	Si(OH)4, NO3-, PO4
Large 4	2,83	-49,03	71	CM	Si(OH)4, NO3-, PO4, NH4
Large 4	2,83	-49,03	72	PoBaSi	Si(OH)4, NO3-
53	2,54	-49,30	73	0-fond	Si(OH)4, NO3-, PO4
54	2,24	-49,57	74	0-fond	Si(OH)4, NO3-, PO4
55	1,94	-49,82	75	0-fond	Si(OH)4, NO3-, PO4
56	1,62	-50,11	76	0-fond	Si(OH)4, NO3-, PO4
Large 5	1,30	-50,37	77	0-fond	Si(OH)4, NO3-, PO4
Large 5	1,30	-50,37	78	CM	Si(OH)4, NO3-, PO4, NH4
58	0,98	-50,64	79	0-fond	Si(OH)4, NO3-, PO4
59	0,66	-50,90	80	0-fond	Si(OH)4, NO3-, PO4
60	0,33	-51,17	81	0-fond	Si(OH)4, NO3-, PO4
61	0,01	-51,43	82	0-fond	Si(OH)4, NO3-, PO4
Super 4	0,00	-51,87	83	CM	Si(OH)4, NO3-, PO4, NH4
Super 4	0,00	-51,87	84	0-fond	Si(OH)4, NO3-, PO4
Super 4	0,00	-51,87	85	REE	-
Super 4	0,00	-51,87	86	PoTh	Si(OH)4, NO3-
Super 4	0,00	-51,87	87	BaSi	Si(OH)4, NO3-
63	0,00	-52,27	88	0-fond	Si(OH)4, NO3-, PO4
64	0,00	-52,60	89	0-fond	Si(OH)4, NO3-, PO4
65	0,00	-52,93	90	0-fond	Si(OH)4, NO3-, PO4
67	0,00	-53,26	92	0-fond	Si(OH)4, NO3-, PO4
68	0,00	-53,59	93	0-fond	Si(OH)4, NO3-, PO4
69	0,00	-53,92	94	0-fond	Si(OH)4, NO3-, PO4
70	0,00	-54,25	95	0-fond	Si(OH)4, NO3-, PO4
71	0,00	-54,58	96	0-fond	Si(OH)4, NO3-, PO4
72	0,00	-54,91	97	0-fond	Si(OH)4, NO3-, PO4
Large 6	0,03	-55,23	98	0-fond	Si(OH)4, NO3-, PO4
Large 6	0,03	-55,23	99	PoBaSi	Si(OH)4, NO3-
Large 6	0,03	-55,23	100	CM	Si(OH)4, NO3-, PO4, NH4
74	0,01	-55,57	101	0-fond	Si(OH)4, NO3-, PO4
75	-0,11	-55,90	102	0-fond	Si(OH)4, NO3-, PO4
76	0,00	-56,23	103	0-fond	Si(OH)4, NO3-, PO4
77	-0,01	-56,76	104	0-fond	Si(OH)4, NO3-, PO4

78	-0,11	-57,21	105	0-fond	Si(OH)4, NO3-, PO4
Super 5	-0,04	-57,55	106	0-fond	Si(OH)4, NO3-, PO4
Super 5	-0,04	-57,55	107	REE	-
Super 5	-0,04	-57,55	108	CM	Si(OH)4, NO3-, PO4, NH4
Super 5	-0,04	-57,55	109	PoTh	Si(OH)4, NO3-
Super 5	-0,04	-57,55	110	BaSi	Si(OH)4, NO3-

Methods

Nutrients were analysed on board. Silicates and nitrates were analysed by standards methods with a Bran+Luebbe AAIII autoanalyser as described by Tréguer and Lecorre (1975). Phosphates samples were analysed using a manual spectrophotometer «Shimatzu UV 1700» as described by Murphy and Riley (1962). Ammonium samples were analysed using a manual spectrophotometer «Shimatzu UV 1700» as described by Koroleff and Solorzano (1969).

Preliminary results

In the upper 300 meters a meridional gradient associated with interfrontal regions is detected, with nitrate concentrations increasing southward of the transect (Fig.15). This gradient may be due to changes in biological production and phytoplancton community structure (shift between coccolithoporids and diatoms for instance).

A northward meridional transport of nitrate is detected at intermediate depths. The latter is linked to the northward flowing of the Antarctic Intermediate Waters (AAIW) that form in the region of the Polar Front and SubAntarctic Mode Waters (SAMW) subducting north of the SAF, and reaching low latitudes (Sarmiento et al, 2004).

Signature of eddies appears north of the SubAntarctic Front in a bowl-shaped feature, corresponding to the anticyclonic M-eddy (e.g., station 36). Depression of the isoplethes of nitrate, silicate and phosphate have all been observed in this anticlynonic eddy.

In deep waters, the influence of North Atlantic deep water (NADW) is depicted by a bulk of lower concentrations between 2000 and 4000 meters depth. A bottom signature of higher concentrations recorded at 36°5 S (e.g., stations 16-17 at the SUPER 1) between 5000 and 4000 meters depth remains unexplained so far, but might be due to a deep gyre of Bottom Antarctic Waters and to remineralisation from the sediments. This feature is detected in the silicates distribution as well.

The highest concentrations of ammonium (> 1.5 mg l^{-1}) were recorded in the subsurface waters centred at around 75 m at the Polar Front. The highest concentration of ammonium correlates with the lowest chl a and phaeopigments concentrations observed in the transect (see Report of Gueneugues & Boye), hence suggests that any diatom blooms generally recorded in this region was already missed in the late austral summer.

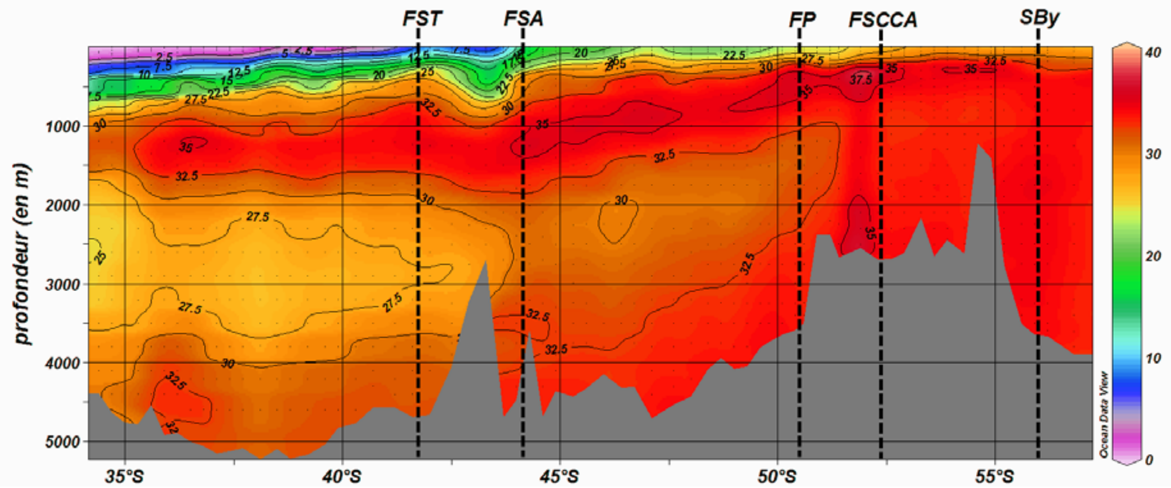


Fig 15- nitrates concentrations (µM) distribution during BONUS-GOODHOPE cruise. Fronts positions are given (M. Arhan, LPO, personnal communication) FST: Subtropical front. FSA: Subantarctic front. FP: Polar front. FSCCA: Southern front of the Antarctic circumpolar current (ACC). Sby: Southern boundarie of ACC.

Furtur work

The nutrients distributions will be further interpreted with the biological activity, phytoplankton assemblage and water-masses circulation pathways in collaboration with several groups of the project.

The uptake rates of the nutrients on the whole productive season will be calculated using these data and compared to the uptake rates obtained in late summer for nitrogen in collaboration with the group of P. Monteiro and H. Waldron, and for silicate in collaboration with R. Corvaisier, D. Cardinal, and F. Fripiat.

Finally the Mode Waters will be further characterised by their Si* signature (Sarmiento *et al.*, 2004) in order to process to budget calculation of the transport of Si* by Mode Waters towards lower latitudes at the base of the ocean permanent thermocline.

The data were already presented and briefly discussed beginning of June, 2008, in the Master-2 report of F. Le Moigne (2008). Distribution des sels nutritifs dans le secteur atlantique de l'Océan Austral en fin de période estivale, Campagne BONUS-GOODHOPE, 35 pp., Master Sciences de la Mer et du Littoral, UBO, Brest, FR ; under the scientific supervision of M. Boye.

2. CHLOROPHYLLE-*a* & PHAEOPIGMENTS

Audrey Guéneuguès (audrey.gueneugues@univ-brest.fr; audrey.gueneugues@orange.fr)
Marie Boye (marie.boye@univ-brest.fr)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Sampling and methodology

Chlorophyll *a* was sampled and analysed on board in order to see the distribution of this pigment. Phaeopigments which represent the degradation product of the chlorophyll *a* were also analysed.

Samples were collected in all CTD hydro (except CTD 0, 1, 4, 6 and 8) and at the CTD for Super and Large stations during the MLD-casts. At the end of the cruise, there are 462 validated data.

Chlorophyll a and phaeopigments are phytoplankton pigments. They are present in the upper 300 meters of the water (Figures 16-17).

So, before taking samples, the sampling depths were determined with the fluorescence CTD-profile. Generally 2 depths were selected in surface, 1 depth in the maximum of fluorescence, 1 depth in the minimum and the remaining where the fluorescence was decreasing. Six depths were sampled and analyzed for the each Hydro CTD casts, 10 depths at the Large stations and 9 depths at Super stations.

One liter per niskin bottle was collected, and then filtrated on GF-F filters with a diameter of 25 mm. Extraction of each filter was done in 6 mL of acetone, and the samples were stored for 4 hours in the fridge. Thereafter the chlorophyll concentration was measured by fluorimetry. After the chlorophyll measurement, 100µL of HCl 1N was added in the tube to have the concentration of phaeopigments. When it was not possible to do the analyses just after the sampling, the filters were stored in a freezer. Filters have to be protected from light and heater.

Preliminary results

The preliminary results show that there is a meridional gradient of chl-a in surface waters (Figure 16). Subsurface maximum of chl-a of about 0.5 μg l^{-1} is depicted from the north of the transect towards the SubAntarctic Front (Figure 16). A decrease of the concentrations to 0.3 μg l^{-1} is then recorded from the SAF to the Polar Front. The lowest chl-a contents (< 0.2 μg l^{-1}) are found between the PF and the Sby, while an increase of the chl-a is again depicted in the Weddel Gyre region south of the SBy (Figure 16).

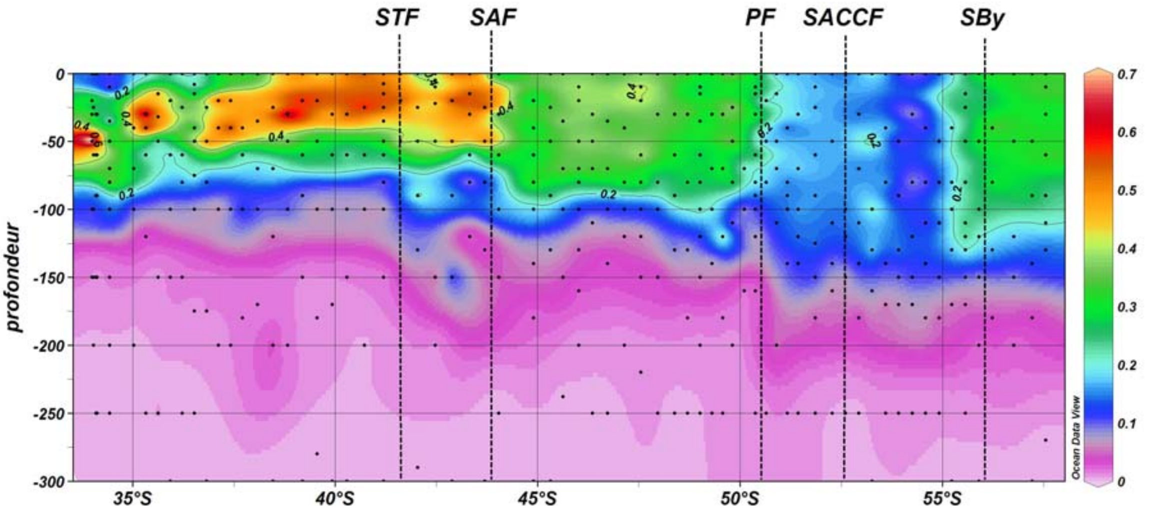


Figure 16- Chlorophyll *a* concentration (µg/L) in the upper 300 m

The phaeopigments meridional gradient mainly follows that of the chlorophyll a, except in the region south of the SBy where the phaeopigment concentrations remain very low (Figure 17). Combining the distributions of chl a and phaeopigments suggest that the phytoplankton was in a senescent stage from the subtropical region towards the PF, while it was in a growing stage south of the SBy. In the Polar Frontal Zone and in the region of the SACCF, the lowest chl a and phaeopigments concentrations that have been recorded in the transect indicate that any of diatom blooms in this region would have been missed during the late austral summer.

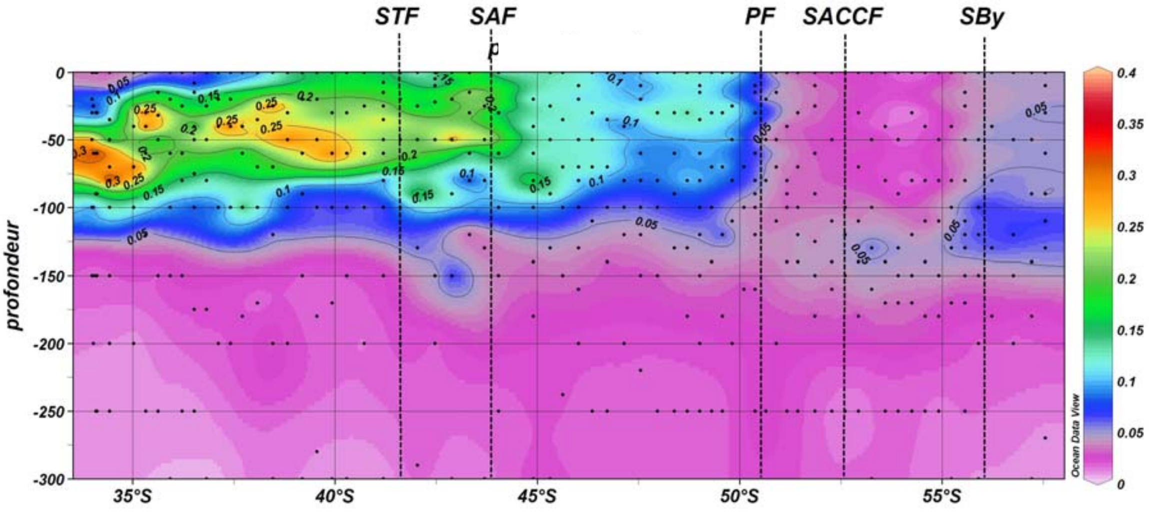


Figure 17- Phaeopigments concentrations (µg/L) in the upper 300 m

Futur work

The distribution of the chlorophyll *a* will have to be understood and interpreted with those of nutrients, taxonomy and pigments to elucidate the phytoplankton assemblages Moreover, the chl a data will be used to calibrate remote sensing colour in collaboration with B. Saulqui (IFREMER, Brest, FR).

The phaeopigments data will be further interpreted with pigments, bacterial activities and regenerated production, such as ammonium to understand the status of the phytoplankton growth stages along the transect.

3. PIGMENTS

Amélie Gelay (amelie.gelay@obs-vlfr.fr; in charge of the sampling)
Joséphine Ras (jras@obs-vlfr.fr; not on board, in charge of the analyses)
Hervé Claustre (claustre@obs-vlfr.fr; not on board, scientific responsible)
LOV – UMR 7093, FR-Villefranche-sur-Mer

The aim of this measurement is to know more about the type of phytoplankton species present in the sampled areas using pigments as proxies. Most of them can be identified by their pigments signature. Water is collected from the rosette, then filtered to collect the cells. The concentrations of major and minor pigments are be measured by HPLC.

Spatial resolution of the sampling:

Pigments have been sampled on every Mixed Layer CTD (Large and Super stations) but also on some Hydro stations, in the upper Niskin bottles only (from the surface to the depth where the minimum of fluorescence is. Fluorescence is measured when the CTD gets down into the water).

Here is the recapitulating table of stations sampled:

Station	n° CTD	long	lat	nbre spl.	Niskin numbers										
3 - Hydro	3	17.24.59 E	33.58.06 S	6	6	7	8	10	11	12					
7 - Hydro	7	16.12.00 E	34.01.999 S	7	15	16	17	18	19	20	21				
9 - Hydro	9	15.09.80 E	34.05.50 S	6	17	18	19	20	21	24					
11 - Large 1	12	14.24.520 E	34.25.600 S	10	1	2	3	4	7	9	10	12	16	21	
14 - Hydro	15	13.51.930 E	35.19.590 S	6	17	18	19	20	21	24					
17 - Hydro	18	13.18.590 E	36.13.400 S	6	17	18	19	20	21	24					
18 - Super 1	20	13.07.120 E	36.31.310 S	9	1	2	3	4	5	11	15	17	18		
19 - Hydro	24	12.55.980 E	36.49.540 S	6	17	18	19	20	21	24					
22 - Hydro	27	12.21.130 E	37.42.950 S	6	17	18	19	20	21	24					
25 - Hydro	30	11.34.350 E	38.49.530 S	6	17	18	19	20	21	24					
29 - Hydro	34	10.33.010 E	40.17.440 S	6	17	18	19	20	21	24					
31 - Large 2	38	09.55.360 E	41.11.400 S	11	1	2	3	4	5	6	9	11	12	14	18
34 - Super 2	45	08.56.050 E	42.28.110 S	9	1	2	3	4	9	11	15	17	18		
38 - Hydro	49	07.37.810 E	44.02.500 S	6	17	18	19	20	21	24					
41 - Large 3	52	06.53.070 E	44.53.880 S	8	1	2	3	4	5	6	11	13			
43 - Hydro	56	06.13.930 E	45.36.680 S	6	17	18	19	20	21	24					
44 - Large 4	58	05.52.390 E	46.01.010 S	9	1	2	3	4	5	6	9	15	24		
48 - Super 3	62	04.22.610 E	47.33.160 S	9	1	2	3	4	5	6	12	16	24		
49 - Hydro	67	03.57.450 E	47.58.200 S	6	17	18	19	20	21	24					
52 - Large 5	71	02.49.920 E	49.01.680 S	11	1	2	3	4	5	6	7	11	13	14	21
54 - Hydro	74	02.13.970 E	49.34.020 S	6	17	18	19	20	21	24					
57 - Large 6	78	01.18.930 E	50.22.480 S	11	1	2	3	4	5	6	10	11	13	14	21
62 - Super 4	83	00.00.040 E	51.50.870 S	9	1	2	3	4	9	10	12	15	18		
64 - Hydro	89	00.00.090 E	52.36.080 S	6	17	18	19	20	21	24					
69 - Hydro	95	00.00.030 E	54.15.000 S	7	16	17	18	19	20	21	24				
73 - Large 7	100	00.00.021 W	55.34.140 S	11	1	2	3	4	5	7	10	11	13	16	24
76 - Hydro	104	00.00.852 W	56.45.736 S	6	17	18	19	20	21	24					

78 - Super 5	108	00.02.252 W	57.33.161 S	8	1 3 4 8 10 12 15 24

Total: 213 samples on 28 stations.

Protocol:

Before the sampling, the chlorophyll concentration in the water column is estimated using the fluorescence signal of the CTD. The depths of sampling are then chosen to have the better resolution of the chlorophyll peak, making sure that the sampling goes from the surface to the depth of the minimum of fluorescence. When the rosette is on board, the water has to be collected as fast as possible to avoid any transformation or degradation of the pigments, or sedimentation of the cells in the Niskin bottles. This has not been possible on the Hydro casts, considering that the priority has not been accorded to the pigments sampling, and that they've been sampled almost one hour after the return of the rosette.

The volume sampled is 2 litres per depth. This water has to be filtered as soon as possible, to avoid any transformation or degradation of the pigments. All the bottles are filtered at the same time on a 12 positions filter holder. Filters used are GF/F Whatman filters of 0,7µm porosity and 25mm diameter. The vacuum from the pump does not exceed 20cm Hg to avoid damaging the plankton cells.

After filtration, the filter is folded and introduced in a cryotube, quickly stored in liquid nitrogen: considering that pigments are heat-sensitive and light-sensitive, any lack of care could drive to an underestimation of their concentration.

Analysis is not done on board. Samples are flown back to France in a dry shipper approved for air transport which can maintain them frozen for at least two weeks. Samples will then be stored at –80°C and will be analysed in Villefranche-sur-Mer by HPLC.

Validated data should be available in October 2008.

4. PARTICULATE ORGANIC CARBON AND NITROGEN; PARTICULATE INORGANIC CARBON

Coralie Perruche (coralie.perruche@univ-brest.fr; on board sampling)
Annick Masson (Annick.Masson@univ-brest.fr)
Marie Boye (marie.boye@univ-brest.fr)
LEMAR- IUEM- Technôpole Brest Iroise- FR-29280 Plouzané

Motivation

The Southern Ocean (SO) acts as a sink for atmospheric CO_2. Primary production at mid-latitude is one of the main contributors to this uptake of CO_2; and its export to deep waters as particulate organic carbon (POC). Furthermore the spatial distribution of the two major bloom-forming taxonomic classes is characterized in the Southern Ocean by massive deposits of coccoliths to the north of the Polar Front (<50°S), as opposed to vast diatom opal deposits just south of the Polar Front (Honjo, 1997). These major phytoplankton functional groups are pivotal in the oceanic carbon cycle with diatoms being major actors of the so-called biological carbon pump in the Southern Ocean, and coccolithophorids acting also as a an additional source for CO_2 with the production of calcium carbonate, PIC being an analogue, (carbonate pump) that in mid-bloom operate CO_2 neutral with a "rain ratio" ($CaCO_3$/Corg) of 1, and at final bloom stages ($CaCO_3$/Corg > 1) may show a net release of CO_2 in the surface waters (Buitenhuis et al., 2001). The rain ratio is pivotal in carbon cycle modelling of past, present and future oceans. The two major phytoplankton groups are also members of a "particles conspiracy", in which the heavy calcite and opal of coccolithophorids (Buitenhuis *et al*, 2001) and diatoms respectively act as ballast (Klaas and Archer, 2002; Francois *et al.*, 2002) for biogenic debris settling into the deep sea, that drives the most pivotal conduite of the biological pump for carbon and other elements (Armstrong *et al*., 2002).
Additionally co-limitations by micro- and macro-nutrients as well as by light and grazing pressure have shown to play an important role in controlling the rates at which macro-nutrients are consumed by phytoplankton. These changes are reflected by differences in the nutrient ratios of the phytoplankton, such as particulate organic nitrogen (PON) over particulate organic carbon (POC).

In the frame of the Bonus-Goodhope project we aim to address the following questions:

- How POC and PIC relate to air-sea CO2 fluxes and to carbon export assessed from geochemical multi-proxy approach in the biologically active mid-latitude zone and Polar Front of the S.O.?
- How POC and PIC relate to phytoplankton assemblage and production in the S.O.?
- How nutrient ratios relate to phytoplankton and to co-limiting factors?
- What is the contribution of mode and intermediate waters subduction to the overall rain ratio transport in late summer?

Sampling

Stations and depths:

A total number of 68 stations have been sampled (the same as sampling for chlorophyll measurements).
POC/PON/PIC have been sampled at each station to have a maximal resolution:

- At HYDRO station, on the hydro cast (6-7 depths of sampling)
- At LARGE and SUPER stations, on the mixed layer cast because of the better vertical resolution (7 to 11 depths of sampling).

Thanks to the fluorescence signal measured during the CTD diving, surface depths of sampling were chosen in order to achieve the best resolution on the chlorophyll peak. At each station, sampling goes from the surface to the depth of the minimum of fluorescence.

PIC/POC/PON sampling:

- 1L for particulate inorganic carbon (PIC)
- 1L for particulate organic carbon and nitrogen (POC/PON)

The water for PIC/POC/PON analyses was collected around 1 hour after the return of the rosette on the deck.

Protocoles

Filtering procedure:

After sampling and chlorophyll filtering, samples for PIC/POC/PON analyses were filtered. 1L of each sampling bottle was precisely measured with a 1L graduated cylinder ("éprouvette"). All samples were progressively filtered on the 3-position filter holder (between two samples, graduated cylinder and filtering support were washed with distilled water). Filters used are GF/F Whatman filters of 0,7µm porosity and 25mm diameter which had been previously burned (to make sure there were no traces of carbon anymore). Once filtering done, filters are folded and stored in tubes at -20°C.

Analyse procedure:

Measurement by "elemental analysis" with CHN device directly for POC/PON, and after "decarbonatation" for PIC

Futur work

The samples will be analysed at LEMAR by A. Masson. The data will be interpreted in collaboration with groups working on carbon export, carbon dioxide fluxes, dissolved organic carbon, nitrogen uptake, and biology in order to further constraint the biological pump and the carbonate pump in the transect of BONUS-GOODHOPE.

5. BIOGENIC SILICA (BSi)

Rudolph Corvaisier (rudolph.corvaisier@univ-brest.fr)
Emilie Grossteffan (emilie.grossteffan@univ-brest.fr)
Philippe Pondaven (philippe.pondaven@univ-brest.fr, not onboard)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

BSi is used as a marker of diatom biomass

Sampling, storage and measurements for BSi

Bottom BSi have been sample for all Large and Super Hydro rosettes.

Mixed Layer BSi have been sample for all Large and Super Hydro rosettes.

Filters (PC, 0.6µM) have been dried and stored at ambient temperature for later analysis of BSi by spectrophotometry after an alkaline digestion at the LEMAR, Plouzané.

Method: Ragueneau & al., *Continental Shelf Research 25 (2005) 697–710.*

6. DISSOLVED ORGANIC CARBON DISTRIBUTION

Bruno Charrière (charriere@univmed.fr; not on board)
Richard Sempéré (sempere@univmed.fr; not onboard)
LMGEM Laboratoire de Microbiologie Geochimie Ecologie Marines (LMGEM)
UMR CNRS 6117
Centre d'Oceanologie de Marseille (COM)
Case 901, Campus de Luminy
FR-13 288 Marseille Cedex 9

Introduction and scientific objectives

The aim of this study is to determine the DOC distribution in the different water masses. DOC is a key parameters for marine environment, it plays a key role in carbon cycle as it represents the largest reservoir of reactive carbon on the Earth (700 GtC comparable to atmospheric pool), moreover DOC pool plays also a key role in the food web, as it is the main source of food for bacterioplankton. DOC concentration in the ocean is mainly the result of biological activity and his distribution is driven by water masses circulation.

Methods

Dissolved organic carbon samples (DOC) were collected at the seven LARGE stations and five SUPER stations (see table). A total of 165 seawater samples were collected using Niskin bottles. In SUPER stations, samples were collected in “hydro” cast and in “MLD” cast (Mixed Layer Depth cast). In “hydro cast”, 10 samples were collected at the same depths than DOC samples for carbon isotopic analyses and were chosen to obtain a profile of concentration in the water column.

At each depth, three aliquots of 25 ml of seawater were collected in pre-combusted ampoules (450°C six hours). Samples were not filtered. They were poisoned with one drop of 85%-phosphoric acid. Then, ampoules were flame-sealed and stored at +4°C in the dark

Station	L1 - St11	S1 - St18	L2 - St31	S2 - St34	L3 - St41	L4 - St44	S3 - St48	L5 - St52	L6 - St56	S4 - St62	L7 - St72	S5 - St78
hydro cast		10		10			10			10		10
MLD cast	10	9	11	9	8	9	9	11	11	9	11	8

DOC measurements

DOC will be analysed by High Temperature Catalytic Oxidation using a Shimadzu TOC-5000 total carbon analyser with a quartz combustion column in the vertical position filled with 1.2% Pt on silica pillows with an approximate diameter of 2mm (Sohrin and Sempéré, 2005).. Briefly, the furnace temperature was maintained at 680 °C and the effluents passed through a mercury trap (gold wire) to remove mercury (Ogawa and Ogura, 1992). A magnesium perchlorate water trap is added to the system located before the halogen scrubber, in addition to an in-line membrane filter and the nondispersive infrared CO2 detector. Prior to analysis, subsamples, acidified with 10 µl of 85% H3PO4 to pH~2 just after the sampling, are sparged for 10 min with CO2-free pure air to remove inorganic carbon as CO2. During the sparging procedure, we followed the recommendations of J.H. Sharp (University of Delaware), i.e., care was taken that during sparging of each sample, seawater did not overflow from the vials. This condition was possible at a gas flow rate of 40 ml min $^{-1}$. One-hundred-microliter injections were repeated three to four times for each sample, the analytical precision of the procedure being within 3% on average. Prior to analyses of standards and samples, the catalyst bed was ‘conditioned’ by injecting 100 µl of acidified and sparged water from a Millipore Milli-Q PlusR system, until the lowest stable integrated area was obtained. To stabilize values for the blank, the catalyst is pre-treated by washing in 1% HCl and gently rinsed with Milli-Q water, and dried in a furnace at a temperature of about 450 °C for 10–15 min.

Sohrin, R.,Sempere, R., (2005) *Seasonal variation in total organic carbon in the Northeast Atlantic in 2000-2001.* J. Geophys. Res. VOL. 110, C10S90, doi:10.1029/2004JC002731

7. TAXONOMY

Ullah Ezat (ullah.ezat@lsce.ipsl.fr; sampling onboard)
LSCE, CEA-CNRS-IPSL
Avenue de la Terrasse
FR-91190 Gif-sur-Yvette

Beatriz Beker (Beatriz.Beker@univ-brest.fr; not onboard)
Marie Boye (marie.boye@univ-brest.fr)
Laboratoire des Sciences de l'Environnement MARin
CNRS UMR6539
Institut Universitaire Européen de la Mer
Technopôle Brest Iroise
FR-29280 Plouzané

Motivation

The spatial resolution of the several frontal systems of the Antarctic Circumpolar Current and of the HNLC region that will be covered is particularly interesting from a biogeochemical point of view since it is expected to show strong meridian gradients of the phytoplankton composition assemblage and production, hence gradients of the biological pump and then of the export of carbon to deep waters. Biological meridian gradients are notably observed for coccolithophorids that are present north of the Polar Front (<50°S ; Honjo, 1997) and prevented to flourish southern, as opposed to vast seasonal bloom of diatoms in the Polar Frontal Zone in repleted Si-condition (de Baar et al., 1995), and to the presence of diatoms in the HNLC region (>50°S) though limited here by at least Fe and light (de Baar et al., 2005) and potentially by Zn (Coale, 1991; Coale et al., 2003).

Within subantarctic waters north of the Polar Front the depletion of silicate is the obvious reason why initially smaller diatom taxa are found, and more northwards no diatoms are found at all anymore.

In turn the primary production and the phytoplankton assemblages need to be further understood in the regions of the BONUS-GOODHOPE transect.

Sampling

Samples were collected in the CTD-Niskin bottles at the maximum of fluorescence and near it by U. Ezat and kept in the dark after addition of a few ml of Lugol.

Analyses

The analyses will be performed by B. Beker at LEMAR using inverted microscope and some pictures will be taken using a scanning electron microscope available at UBO.

8. COCCOLITHOPHORIDS

Ullah Ezat (ullah.ezat@lsce.ipsl.fr; sampling onboard)
LSCE, CEA-CNRS-IPSL
Avenue de la Terrasse
FR-91190 Gif-sur-Yvette

Luc Beaufort (beaufort@cerege.fr; not onboard)
CEREGE
Europôle de l’Arbois
FR-Aix-en-Provence

Motivation

As mentioned here above (section 9), coccolithophorids are mainly present north of the Polar Front (<50°S ; Honjo, 1997) and prevented to flourish southern.
Furthermore coccolithophorids are main producers of alkenones (a biomarker of SST) and also DMS-producers, a gas with climatic impact.

Sampling

Samples were collected in the CTD-Niskin bottles at the maximum of fluorescence and near it by U. Ezat and filtered on the ship.

Samples were then oven dried (at ~50°C).

Analyses

The analyses will be performed by the group of L. Beaufort at CEREGE using microscope determinations and counting.

The results will be compared with the taxonomy, the pigments, and used for the alkenones SST-proxy calibration as well as for the "white signals" of remote sensing calibration in collaboration with B. Saulqui and M. Boye.

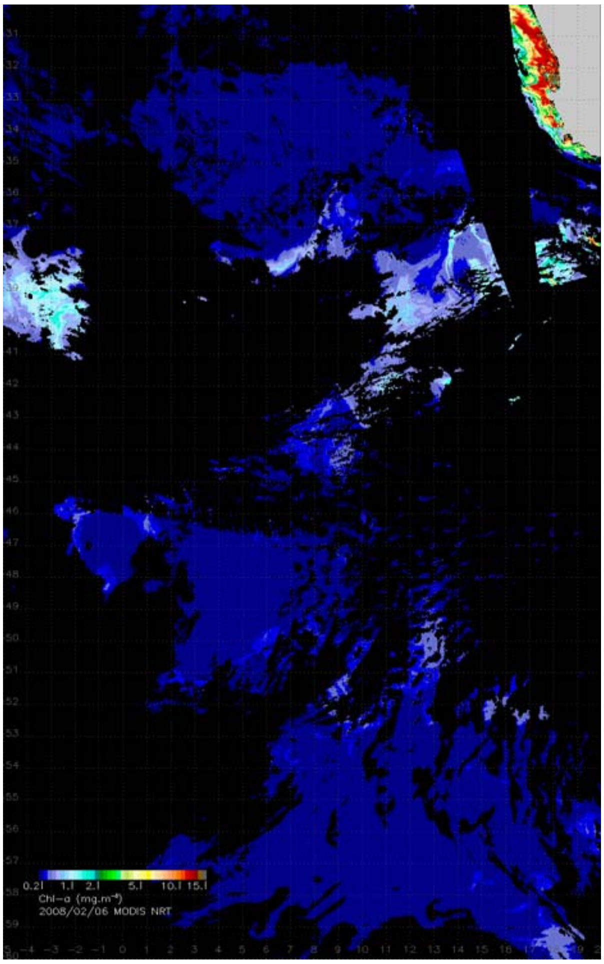
9. Satellite observations

Bertrand Saulqui (bsaulqui@ifremer.fr; not onboard)
DYNECO
IFREMER
FR-29280 Plouzané

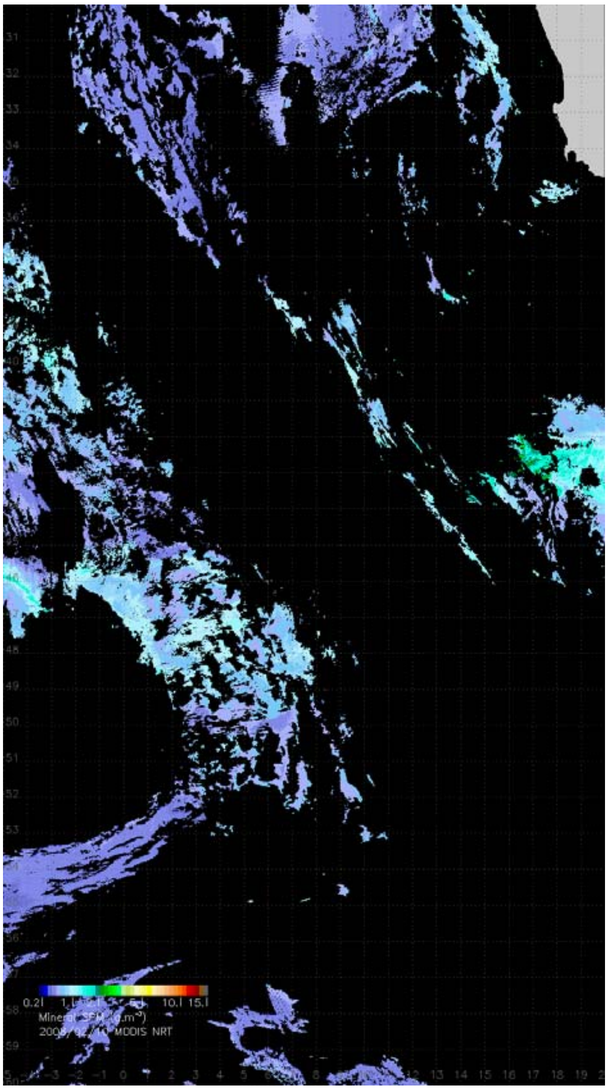
Ocean colour images for different variables were recorder by B. Saulqui. MERIS and MODIS fields for chl-a (Picture 3), suspended matter (Picture 4), and the "white signals" that characterise the coccolithophorid blooms are treated beforehand.

By the duration of the cruise, the images were most of the time very patchy because of the satellite orbit and the cloud cover. Therefore it has been mostly impossible to use them on board to adapt the biogeochemical station position strategy.

Satellite ocean colour and white-signals pictures will be further calibrated with the in situ chl-a and coccolithophorids counting recorded in the surface waters along the cruise transect.



Picture 3- Chl a concentration issued from MODIS (08/02/06)



Picture 4- Atmospheric suspended matter issued from MODIS (08/02/10)

SURFICIAL SEDIMENTS and PORE WATERS

See annexe 4 for benthic work

PLANNED POST-CRUISE MEETING and CONFERENCES

According to the initial plan written in the proposal and to what was discussed and decided on the ship at the final scientific meetings hold on March, 21 and 22th, 2008, a post-cruise meeting will be organized within no later than one year after the end of the cruise.

Furthermore it was decided that the results available during the first year after the end of the cruise will be presented to scientific conferences.

The ASLO Aquatic Science Meeting (http://www.aslo.org/forms/nice2009.html), on January, 25-30, 2009 (Nice, France) is providing a suitable platform for BONUS-GOODHOPE multidisciplinary scientific issues presentations; and the geographic proximity with the Laboratoire d'Océanographie de Villefranche (LOV, FR-Villefranche-sur-Mer) is convenient to organise the post-cruise meeting and to decrease the travel costs.

1. ASLO

A special session entitled "The Southern Ocean during the International Polar Year" was submitted for the BONUS-GOODHOPE team to attend the ASLO meeting; with convenors: M. Boye, S. Speich, F. Dehairs, F. Lacan, D. Cardinal, C. Jeandel.

An additional special session entitled "IPY-GEOTRACES: Trace elements and isotopes in Polar Oceans" was also submitted to ASLO with convenors: H.J.W. de Baar, M. Boye; where the GEOTRACES participants of the BONUS-GOODHOPE project will be able to additionally present their results.

2. Post-cruise meeting

It is then proposed to have the post-cruise meeting at LOV either before (09/01/24-25) or after (09/01/30-31) the ASLO meeting.

3. SCAR-IASC-IPY

Previously according to the plan made on board at the final scientific meetings, the preliminary results of the BONUS-GOODHOPE cruise will be presented by M. Boye to the upcoming SCAR-IASC-IPY open science conference (http://www.scar-iasc-ipy2008.org/), on July 8-11, 2008 at St. Petersburg (Russia).

Bonus Good Hope 2008 Logbook Report

Elodie Kestenare (Logbook keeper on board)
and
Marie-Paule Torre (Database keeper)

The logbook is a crucial part of the LEFE-CYBER database management process for an oceanographic cruise, and it was conceived and maintained by the “BGH Database” committee.

This report briefly describes the logbook which was maintained during the cruise. The aims of the logbook are to record all the operations on board, to list all the sampling and measured parameters (analyzed on board or later) in order to establish a unique reference system.

The logbook information comprises three main categories:
- details of the operations undertaken on board,
- inventory of the sampling carried out for each instrument,
- characterization and inventory of all of the biogeochemical and physical parameters (both oceanic and atmospheric), in order to update and complete the data dictionary.

This work has been carried out using different tables, comprising the deployments, sampling, measurements, etc... which were obtained in direct interaction with the scientists on board. From these specific tables, Excel files were systematically created. They constitute the logbook, a requested preliminary step for the BGH database.

(1) CHRONOLOGY OF ALL OF THE ON BOARD OPERATIONS: “JOURNAL PASSERELLE”

This is an inventory of the daily operations which occurred on board, including the deployment and recovery of instruments (CTD rosette frame, GOFLO bottles, In situ pumps, multi-corer Oktupus) and launching of devices (PROVOR floats, XBTs, C-PIES, Radiosondes)

1-A. “OCEAN” OPERATIONS

Date Hour UT	(Local - TU)	Longitude	Latitude	Type of station	# station	Code	Number	Action	Comments
hh:mm	hh	deg.minutes	deg.minutes			Instrument			
13/02/08 14:43	2	18.07.140 E	33.58.560 S	XBT	*1*	XBT	1	Largage	
13/02/08 18:20	2	17.13.58 E	33.58.58 S	Hydro test	0	CTD	0	Mise à l'eau	
13/02/08 20:15	2	17.13.58 E	33.58.58 S	Hydro test	0	CTD	0	Mise à bord	
13/02/08 23:47	2	17.57.37 E	33.56.33 S	Hydro	1	CTD	1	Mise à l'eau	
14/02/08 00:17	2	17.57.337 E	33.56.384 S	Hydro	1	CTD	1	Mise à bord	
14/02/08 01:29	2	17.43.220 E	33.56.660 S	XBT	*2*	XBT	2	Largage	
14/02/08 02:46	2	17.31.36 E	33.57.635 S	Hydro	2	CTD	2	Mise à l'eau	
14/02/08 03:40	2	17.31.278 E	33.57.737 S	Hydro	2	CTD	2	Mise à bord	
14/02/08 04:08	2	17.27.120 E	33.57.950 S	XBT	*3*	XBT	3	Largage	
14/02/08 05:56	2	17.24.59 E	33.58.06 S	Hydro	3	CTD	3	Mise à l'eau	
14/02/08 07:01	2	17.24.00 E	33.58.00 S	Hydro	3	CTD	3	Mise à bord	
14/02/08 07:54	2	17.24.498 E	33.58.221 S	Hydro	3	CPIES	1	Largage	
14/02/08 09:58	2	17.18.21 E	33.58.46 S	Hydro	4	CTD	4	Mise à l'eau	
14/02/08 11:37	2	17.18.21 E	33.58.56 S	Hydro	4	CTD	4	Mise à bord	
14/02/08 12:34	2	17.08.47 E	33.58.92 S	XBT	*4*	XBT	4	Largage	
14/02/08 13:55	2	16.57.13 E	33.59.68 S	Hydro	5	CTD	5	Mise à l'eau	
14/02/08 16:10	2	16.57.176 E	33.59.502 S	Hydro	5	CTD	5	Mise à bord	
14/02/08 17:05	2	16.45.91 E	34.00.18 S	XBT	*5*	XBT	5	Largage	
14/02/08 18:09	2	16.35.22 E	34.00.74 S	Hydro	6	CTD	6	Mise à l'eau	
14/02/08 21:04	2	16.35.264 E	34.00.802 S	Hydro	6	CTD	6	Mise à bord	
14/02/08 22:01	2	16.24.260 E	34.01.360 S	XBT	*6*	XBT	6	Largage	
14/02/08 23:14	2	16.12.00 E	34.01.999 S	Hydro	7	CTD	7	Mise à l'eau	
15/02/08 02:34	2	16.12.00 E	34.01.999 S	Hydro	7	CTD	7	Mise à bord	
15/02/08 04:00	2	15.52.500 E	34.03.219 S	XBT	*7*	XBT	7	Largage	
15/02/08 04:59	2	15.41.20 E	34.03.79 S	Hydro	8	CTD	8	Mise à l'eau	
15/02/08 09:07	2	15.41.759 E	34.03.682 S	Hydro	8	CTD	8	Mise à bord	
16/02/08 06:52	2	15.25.720 E	34.04.55 S	XBT	*8*	XBT	8	Largage	
16/02/08 08:14	2	15.09.80 E	34.05.50 S	Hydro	9	CTD	9	Mise à l'eau	
16/02/08 11:57	2	15.09.707 E	34.05.551 S	Hydro	9	CTD	9	Mise à bord	
16/02/08 12:12	2	15.09.740 E	34.05.440 S	Hydro	9	CPIES	2	Largage	
16/02/08 14:51	2	14.51.19 E	34.06.39 S	XBT	*9*	XBT	9	Largage	
16/02/08 19:15	2	14.37.98 E	34.07.37 S	Hydro	10	CTD	10	Mise à l'eau	
16/02/08 23:24	2	14.35.282 E	34.07.336 S	Hydro	10	CTD	10	Mise à bord	

16/02/08 23:27	2	14.35.29 E	34.07.320 S	XBT	*10*	XBT	10	Largage	
17/02/08 00:31	2	14.29.180 E	34.16.440 S	XBT	*11*	XBT	11	Largage	
17/02/08 04:27	2	14.24.29 E	34.25.67 S	Large	11	CTD	11	Mise à l'eau	Large1A Hydro 0-bottom
17/02/08 09:03	2	14.24.344 E	34.25.592 S	Large	11	CTD	11	Mise à bord	Large1A Hydro 0-bottom
17/02/08 09:35	2	14.24.358 E	34.25.553 S	Large	11	GOFLO	1	Mise à l'eau	Large1A TM's 0-2100m
17/02/08 12:12	2	14.24.526 E	34.25.606 S	Large	11	GOFLO	1	Mise à bord	Large1A TM's 0-2100m
17/02/08 13:40	2	14.24.520 E	34.25.600 S	Large	11	CTD	12	Mise à l'eau	Large1A Mixed Layer 0-250m
17/02/08 14:24	2	14.24.550 E	34.25.638 S	Large	11	CTD	12	Mise à bord	Large1A Mixed Layer 0-250m
17/02/08 15:26	2	14.17.930 E	34.35.170 S	XBT	*12*	XBT	12	Largage	
17/02/08 16:19	2	14.13.570 E	34.43.425 S	Hydro	12	CTD	13	Mise à l'eau	
17/02/08 20:41	2	14.13.399 E	34.43.470 S	Hydro	12	CTD	13	Mise à bord	
17/02/08 21:50	2	14.07.160 E	34.53.840 S	XBT	*13*	XBT	13	Largage	XBT fail at 34 m – redo (see 14)
17/02/08 21:52	2	14.06.910 E	34.54.310 S	XBT	*14*	XBT	14	Largage	
17/02/08 23:01	2	14.02.780 E	35.01.600 S	Hydro	13	CTD	14	Mise à l'eau	
18/02/08 04:35	2	14.02.982 E	35.01.640 S	Hydro	13	CTD	14	Mise à bord	
18/02/08 05:32	2	13.56.890 E	35.11.209 S	XBT	*15*	XBT	15	Largage	
18/02/08 06:35	2	13.51.930 E	35.19.590 S	Hydro	14	CTD	15	Mise à l'eau	
18/02/08 10:15	2	13.51.931 E	35.19.596 S	Hydro	14	CTD	15	Mise à bord	
18/02/08 11:32	2	13.44.350 E	35.31.390 S	XBT	*16*	XBT	16	Largage	
18/02/08 12:30	2	13.41.010 E	35.37.510 S	Hydro	15	CTD	16	Mise à l'eau	
18/02/08 16:01	2	13.40.972 E	35.37.532 S	Hydro	15	CTD	16	Mise à bord	
18/02/08 17:08	2	13.34.350 E	35.48.130 S	XBT	*17*	XBT	17	Largage	
18/02/08 18:10	2	13.29.820 E	35.55.520 S	Hydro	16	CTD	17	Mise à l'eau	
18/02/08 22:05	2	13.31.195 E	35.55.354 S	Hydro	16	CTD	17	Mise à bord	
18/02/08 23:06	2	13.25.230 E	36.03.980 S	XBT	*18*	XBT	18	Largage	XBT fail at 441 m – redo (see 19)
18/02/08 23:11	2	13.24.570 E	36.04.840 S	XBT	*19*	XBT	19	Largage	
19/02/08 02:44	2	13.18.590 E	36.13.400 S	Hydro	17	CTD	18	Mise à l'eau	
19/02/08 10:17	2	13.19.399 E	36.12.622 S	Hydro	17	CTD	18	Mise à bord	
19/02/08 11:25	2	13.13.280 E	36.21.840 S	XBT	*20*	XBT	20	Largage	
19/02/08 12:00	2	13.10.455 E	36.26.537 S	Super	18	OKTOPUS	1	Mise à l'eau	
19/02/08 17:00	2	13.10.455 E	36.26.537 S	Super	18	OKTOPUS	1	Mise à bord	Super1 7 carottes sur 8
19/02/08 17:54	2	13.07.320 E	36.31.370 S	Super	18	CTD	19	Mise à l'eau	Super1 Hydro 0-bottom
19/02/08 22:09	2	13.06.767 E	36.30.822 S	Super	18	CTD	19	Mise à bord	Super1 Hydro 0-bottom
19/02/08 22:57	2	13.07.000 E	36.31.000 S	Super	18	GOFLO	2	Mise à l'eau	Super1 TM's 0-800m
20/02/08 01:26	2	13.06.000 E	36.30.000 S	Super	18	GOFLO	2	Mise à bord	Super1 TM's 0-800m
20/02/08 02:06	2	13.07.120 E	36.31.310 S	Super	18	CTD	20	Mise à l'eau	Super1 Mixed Layer 0-250m

20/02/08 05:06	2	13.06.974 E	36.31.536 S	Super	18	CTD	20	Mise à bord	Super1 Mixed Layer 0-250m
20/02/08 07:30	2	13.07.139 E	36.31.258 S	Super	18	PIS	1	Mise à l'eau	Super1 234Th,210Po,14C,Biomark 0-750m
20/02/08 11:30	2	13.07.139 E	36.31.255 S	Super	18	PIS	1	Mise à bord	Super1 234Th,210Po,14C,Biomark 0-750m
20/02/08 12:01	2	13.07.140 E	36.31.250 S	Super	18	CTD	21	Mise à l'eau	Super1 REE 0-bottom
20/02/08 15:52	2	13.07.096 E	36.31.278 S	Super	18	CTD	21	Mise à bord	Super1 REE 0-bottom
20/02/08 16:37	2	13.07.180 E	36.31.350 S	Super	18	GOFLO	3	Mise à l'eau	Super1 TM's 1000-3500m
20/02/08 21:31	2	13.05.000 E	36.28.000 S	Super	18	GOFLO	3	Mise à bord	Super1 TM's 1000-3500m
20/02/08 22:25	2	13.07.330 E	36.31.800 S	Super	18	PIS	2	Mise à l'eau	Super1 230Th,Pa,Nd,30Si,14C 0-bottom
21/02/08 05:25	2	13.08.650 E	36.28.040 S	Super	18	PIS	2	Mise à bord	Super1 230Th,Pa,Nd,30Si,14C 0-bottom
21/02/08 06:08	2	13.07.448 E	36.31.021 S	Super	18	GOFLO	4	Mise à l'eau	Super1 Incub Fluo max
21/02/08 06:53	2	13.07.133 E	36.30.403 S	Super	18	GOFLO	4	Mise à bord	Super1 Incub Fluo max
21/02/08 07:32	2	13.07.090 E	36.30.370 S	Super	18	CTD	22	Mise à l'eau	Super1 234Th,210Po,Ra 0-1000m
21/02/08 09:00	2	13.06.997 E	36.29.755 S	Super	18	CTD	22	Mise à bord	Super1 234Th,210Po,Ra 0-1000m
21/02/08 09:27	2	13.06.976 E	36.29.492 S	Super	18	GOFLO	5	Mise à l'eau	Super1 Incub Fluo max
21/02/08 10:39	2	13.06.422 E	36.28.437 S	Super	18	GOFLO	5	Mise à bord	Super1 Incub Fluo max
21/02/08 11:07	2	13.06.300 E	36.28.140 S	Super	18	CTD	23	Mise à l'eau	Super1 Ba, 30Si, Ra 0-1000m
21/02/08 12:46	2	13.06.000 E	36.25.999 S	Super	18	CTD	23	Mise à bord	Super1 Ba, 30Si, Ra 0-1000m
21/02/08 13:43	2	13.06.246 E	36.27.997 S	Super	18	GOFLO	6	Mise à l'eau	Super1 Incub Fluo max
21/02/08 14:26	2	13.06.048 E	36.27.497 S	Super	18	GOFLO	6	Mise à bord	Super1 Incub Fluo max
21/02/08 14:39	2	13.06.057 E	36.27.435 S	Super	18	Filet Plancton	1	Mise à l'eau	
21/02/08 14:54	2	13.06.039 E	36.27.469 S	Super	18	Filet Plancton	1	Mise à bord	
21/02/08 15:50	2	13.07.177 E	36.31.321 S	Super	18	GOFLO	7	Mise à l'eau	Super1 Cd 0-300m
21/02/08 16:29	2	13.06.000 E	36.31.000 S	Super	18	GOFLO	7	Mise à bord	Super1 Cd 0-300m
21/02/08 17:07	2	13.06.705 E	36.29.799 S	Super	18	PIS	3	Mise à l'eau	Super1 Ra, REE, 14C, Biomark 0-bottom
22/02/08 00:30	2	13.06.311 E	36.29.105 S	Super	18	PIS	3	Mise à bord	Super1 Ra, REE, 14C, Biomark 0-bottom
22/02/08 01:50	2	13.07.110 E	36.30.470 S	Super	18	GOFLO	8	Mise à l'eau	Super1 Fe isotopes 0-4000m
22/02/08 06:01	2	13.07.377 E	36.27.800 S	Super	18	GOFLO	8	Mise à bord	Super1 Fe isotopes 0-4000m
22/02/08 07:28	2	12.59.210 E	36.42.910 S	XBT	*21*	XBT	21	Largage	
22/02/08 08:22	2	12.55.980 E	36.49.540 S	Hydro	19	CTD	24	Mise à l'eau	
22/02/08 13:38	2	12.56.210 E	36.47.220 S	Hydro	19	CTD	24	Mise à bord	
22/02/08 14:50	2	12.49.960 E	36.58.140 S	XBT	*22*	XBT	22	Largage	
22/02/08 16:00	2	12.44.340 E	37.07.040 S	Hydro	20	CTD	25	Mise à l'eau	
22/02/08 20:51	2	12.44.326 E	36.06.226 S	Hydro	20	CTD	25	Mise à bord	
22/02/08 21:49	2	12.38.060 E	37.16.270 S	XBT	*23*	XBT	23	Largage	
22/02/08 23:06	2	12.32.740 E	37.25.010 S	Hydro	21	CTD	26	Mise à l'eau	

23/02/08 03:10	2	12.32.742 E	37.24.986 S	Hydro	21	CTD	26	Mise à bord	
23/02/08 04:03	2	12.26.630 E	37.34.250 S	XBT	*24*	XBT	24	Largage	
23/02/08 05:00	2	12.21.130 E	37.42.950 S	Hydro	22	CTD	27	Mise à l'eau	
23/02/08 09:31	2	12.21.130 E	37.42.970 S	Hydro	22	CTD	27	Mise à bord	
23/02/08 10:28	2	12.14.350 E	37.51.750 S	XBT	*25*	XBT	25	Largage	
23/02/08 11:16	2	12.07.580 E	38.01.130 S	XBT	*26*	XBT	26	Largage	
23/02/08 12:07	2	12.05.110 E	38.05.510 S	Hydro	23	CTD	28	Mise à l'eau	
23/02/08 16:35	2	12.05.110 E	38.05.470 S	Hydro	23	CTD	28	Mise à bord	
23/02/08 17:31	2	12.00:560 E	38.12.240 S	XBT	*27*	XBT	27	Largage	
23/02/08 18:15	2	11:55:000 E	38.20.160 S	XBT	*28*	XBT	28	Largage	
23/02/08 19:14	2	11.49.780 E	38.27.490 S	Hydro	24	CTD	29	Mise à l'eau	
23/02/08 23:40	2	11.49.802 E	38.27.548 S	Hydro	24	CTD	29	Mise à bord	
24/02/08 00:40	2	11.44.240 E	38.35.360 S	XBT	*29*	XBT	29	Largage	
24/02/08 01:20	2	11.39.340 E	38.42.580 S	XBT	*30*	XBT	30	Largage	
24/02/08 02:14	2	11.34.350 E	38.49.530 S	Hydro	25	CTD	30	Mise à l'eau	
24/02/08 06:25	2	11.34.524 E	38.49.592 S	Hydro	25	CTD	30	Mise à bord	
24/02/08 07:48	2	11.25.610 E	39.02.290 S	XBT	*31*	XBT	31	Largage	
24/02/08 08:20	2	11.21.390 E	39.08.370 S	XBT	*32*	XBT	32	Largage	
24/02/08 09:00	2	11.19.110 E	39.11.460 S	Hydro	26	CTD	31	Mise à l'eau	
24/02/08 13:29	2	11.19.450 E	39.11.490 S	Hydro	26	CTD	31	Mise à bord	
24/02/08 14:16	2	11.13.930 E	39.19.170 S	XBT	*33*	XBT	33	Largage	
24/02/08 14:51	2	11.08.850 E	39.26.300 S	XBT	*34*	XBT	34	Largage	
24/02/08 15:46	2	11.03.730 E	39.33.540 S	Hydro	27	CTD	32	Mise à l'eau	
24/02/08 20:10	2	11.03.740 E	39.33.540 S	Hydro	27	CTD	32	Mise à bord	
24/02/08 20:57	2	10.58.720 E	39.40.730 S	XBT	*35*	XBT	35	Largage	
24/02/08 21:29	2	10.54.150 E	39.47.380 S	XBT	*36*	XBT	36	Largage	
24/02/08 22:37	2	10.48.320 E	39.55.520 S	Hydro	28	CTD	33	Mise à l'eau	
25/02/08 02:32	2	10.48.370 E	39.55.537 S	Hydro	28	CTD	33	Mise à bord	
25/02/08 02:51	2	10.48.531 E	39.55.579 S	PROVOR	*1*	PROVOR	1	Largage	PV 607 (2000m)
25/02/08 04:08	2	10.37.520 E	40.10.280 S	XBT	*37*	XBT	37	Largage	
25/02/08 04:55	2	10.33.010 E	40.17.440 S	Hydro	29	CTD	34	Mise à l'eau	
25/02/08 08:50	2	10.33.430 E	40.17.473 S	Hydro	29	CTD	34	Mise à bord	
25/02/08 09:52	2	10.25.570 E	40.27.250 S	XBT	*38*	XBT	38	Largage	
25/02/08 10:30	2	10.19.620 E	40.34.680 S	XBT	*39*	XBT	39	Largage	
25/02/08 11:36	2	10.12.870 E	40.43.390 S	Hydro	30	CTD	35	Mise à l'eau	
25/02/08 15:06	2	10.12.870 E	40.43.390 S	Hydro	30	CTD	35	Mise à bord	

25/02/08 15:56	2	10.07.240 E	40.51.660 S	XBT	*40*	XBT	40	Largage	
25/02/08 16:35	2	10.01.870 E	41.00.110 S	XBT	*41*	XBT	41	Largage	
25/02/08 17:30	2	09.55.040 E	41.10.520 S	Large	31	CTD	36	Mise à l'eau	Large 2B PAR
25/02/08 18:05	2	09.55.048 E	41.10.610 S	Large	31	CTD	36	Mise à bord	Large 2B PAR
25/02/08 18:10	2	09.55.010 E	41.10.560 S	Large	31	CTD	37	Mise à l'eau	Large2B Hydro 0-bottom
25/02/08 21:40	2	09.55.057 E	41.10.705 S	Large	31	CTD	37	Mise à bord	Large2B Hydro 0-bottom
25/02/08 22:06	2	09.55.010 E	41.10.710 S	Large	31	GOFLO	9	Mise à l'eau	Large2B TM's 0-2100m
26/02/08 00:26	2	09.55.280 E	41.11.280 S	Large	31	GOFLO	9	Mise à bord	Large2B TM's 0-2100m
26/02/08 00:45	2	09.55.360 E	41.11.400 S	Large	31	CTD	38	Mise à l'eau	Large2B Mixed Layer 0-300m
26/02/08 01:37	2	09.55.313 E	41.11.390 S	Large	31	CTD	38	Mise à bord	Large2B Mixed Layer
26/02/08 03:10	2	09:41:240 E	41.28.310 S	XBT	*43*	XBT	43	Largage	Pas de #42: probleme increment
26/02/08 04:03	2	09.35.009 E	41.36.520 S	Hydro	32	CTD	39	Mise à l'eau	
26/02/08 07:52	2	09.35.006 E	41.36:521 S	Hydro	32	CTD	39	Mise à bord	
26/02/08 08:04	2	09.34.680 E	41.36.220 S	PROVOR	*2*	PROVOR	2	Largage	PV 617 (2000m)
26/02/08 08:52	2	09.28.960 E	41.44.840 S	XBT	*44*	XBT	44	Largage	
26/02/08 09:33	2	09.22.750 E	41.53.320 S	XBT	*45*	XBT	45	Largage	
26/02/08 10:28	2	09.16.270 E	42.07.240 S	Hydro	33	CTD	40	Mise à l'eau	
26/02/08 14:00	2	09.16.260 E	42.02.290 S	Hydro	33	CTD	40	Mise à bord	
26/02/08 15:11	2	09.09.620 E	42.10.590 S	XBT	*46*	XBT	46	Largage	
26/02/08 16:00	2	09.05.940 E	42.15.150 S	Super	34	OKTOPUS	2	Mise à l'eau	
26/02/08 19:00	2	09.05.940 E	42.15.150 S	Super	34	OKTOPUS	2	Mise à bord	Super2 Environ 5cm sur une carotte
26/02/08 19:24	2	09.02.160 E	42.19.890 S	XBT	*47*	XBT	47	Largage	
26/02/08 20:31	2	08.55.700 E	42.28.170 S	Super	34	CTD	41	Mise à l'eau	Super2 Hydro 0-bottom
26/02/08 23:47	2	08.55.696 E	42.28.163 S	Super	34	CTD	41	Mise à bord	Super2 Hydro 0-bottom
27/02/08 00:23	2	08.55.718 E	42.28.190 S	Super	34	GOFLO	10	Mise à l'eau	Super2 TM's 1500-4000m
27/02/08 04:10	2	08.55.731 E	42.28.191 S	Super	34	GOFLO	10	Mise à bord	Super2 TM's 1500-4000m
27/02/08 05:00	2	08.55.726 E	42.28.146 S	Super	34	PIS	4	Mise à l'eau	Super2 Tracers 0-4000m
27/02/08 12:04	2	08.55.723 E	42.28.134 S	Super	34	PIS	4	Mise à bord	Super2 Tracers 0-4000m
27/02/08 12:34	2	08.55.726 E	42.28.135 S	Super	34	GOFLO	11	Mise à l'eau	Super2 TM's 200-1500m
27/02/08 14:20	2	08.55.730 E	42.28.127 S	Super	34	GOFLO	11	Mise à bord	Super2 TM's 200-1500m
27/02/08 14:45	2	08.55.850 E	42.28.200 S	Super	34	CTD	42	Mise à l'eau	Super2 REE 0-bottom
27/02/08 17:50	2	08.55.840 E	42.28.200 S	Super	34	CTD	42	Mise à bord	Super2 REE 0-bottom
27/02/08 18:07	2	08.55.854 E	42.28.210 S	Super	34	GOFLO	12	Mise à l'eau	Super2 TM's 0-200m
27/02/08 18:50	2	08.56.149 E	42.28.354 S	Super	34	GOFLO	12	Mise à bord	Super2 TM's 0-200m
27/02/08 19:24	2	08.56.050 E	42.28.270 S	Super	34	CTD	43	Mise à l'eau	Super2 234Th,210Po,Ra 0-1000m
27/02/08 20:30	2	08.56.004 E	42.28.297 S	Super	34	CTD	43	Mise à bord	Super2 234Th,210Po,Ra 0-1000m

27/02/08 21:12	2	08.55.850 E	42.28.133 S	Super	34	GOFLO	13	Mise à l'eau	Super2 Incub Fluo Max
27/02/08 22:11	2	08.55.975 E	42.28.111 S	Super	34	GOFLO	13	Mise à bord	Super2 Incub Fluo Max
27/02/08 22:26	2	08.55.970 E	42.28.110 S	Super	34	CTD	44	Mise à l'eau	Super2 Ba, 30Si, Ra 0-1000m
28/02/08 00:12	2	08.55.912 E	42.28.130 S	Super	34	CTD	44	Mise à bord	Super2 Ba, 30Si, Ra 0-1000m
28/02/08 00:38	2	08.55.970 E	42.28.112 S	Super	34	PIS	5	Mise à l'eau	Super2 Tracers 0-4000m
28/02/08 07:30	2	08.55.960 E	42.28.110 S	Super	34	PIS	5	Mise à bord	Super2 Tracers 0-4000m
28/02/08 07:50	2	08.55.970 E	42.28.120 S	Super	34	GOFLO	14	Mise à l'eau	Super2 Incub Fluo Max
28/02/08 08:26	2	08.56.000 E	42.28.120 S	Super	34	GOFLO	14	Mise à bord	Super2 Incub Fluo Max
28/02/08 08:45	2	08.56.050 E	42.28.110 S	Super	34	CTD	45	Mise à l'eau	Super2 Mixed Layer 0-250m
28/02/08 09:08	2	08.56.023 E	42.28.118 S	Super	34	CTD	45	Mise à bord	Super2 Mixed Layer 0-250m
28/02/08 09:30	2	08.56.050 E	42.28.110 S	Super	34	GOFLO	15	Mise à l'eau	Super2 Incub + TM's Fluo Max
28/02/08 09:50	2	08.56.050 E	42.28.110 S	Super	34	GOFLO	15	Mise à bord	Super2 Incub + TM's Fluo Max
28/02/08 10:53	2	08.48.920 E	42.36.480 S	XBT	*48*	XBT	48	Largage	
28/02/08 11:48	2	08.40.560 E	42.46.810 S	XBT	*49*	XBT	49	Largage	
28/02/08 12:50	2	08.34.970 E	42.53.580 S	Hydro	35	CTD	46	Mise à l'eau	
28/02/08 15:40	2	08.32.354 E	42.53.497 S	Hydro	35	CTD	46	Mise à bord	
28/02/08 16:36	2	08.28.610 E	43.01.630 S	XBT	*50*	XBT	50	Largage	Spike at 434m: redo
28/02/08 16:43	2	08.27.660 E	43.02.780 S	XBT	*51*	XBT	51	Largage	Spike at 614m
28/02/08 17:34	2	08.20.820 E	43.11.070 S	XBT	*52*	XBT	52	Largage	
28/02/08 18:45	2	08.14.230 E	43.19.460 S	Hydro	36	CTD	47	Mise à l'eau	
28/02/08 21:00	2	08.14.179 E	43.19.477 S	Hydro	36	CTD	47	Mise à bord	
28/02/08 21:13	2	08.13.380 E	43.20.130 S	PROVOR	*3*	PROVOR	3	Largage	PV 620 (2000m)
28/02/08 21:58	2	08.08.660 E	43.26.350 S	XBT	*53*	XBT	53	Largage	
28/02/08 22:42	2	08.02.370 E	43.33.590 S	XBT	*54*	XBT	54	Largage	
28/02/08 23:56	2	07.56.140 E	43.40.950 S	Hydro	37	CTD	48	Mise à l'eau	
29/02/08 03:50	2	08.00.661 E	43.41.940 S	Hydro	37	CTD	48	Mise à bord	
29/02/08 04:54	2	07.51.820 E	43.48.060 S	XBT	*55*	XBT	55	Largage	
29/02/08 05:47	2	07.43.660 E	43.55.420 S	XBT	*56*	XBT	56	Largage	
29/02/08 06:55	2	07.37.810 E	44.02.500 S	Hydro	38	CTD	49	Mise à l'eau	
29/02/08 10:32	2	07.37.840 E	44.02.443 S	Hydro	38	CTD	49	Mise à bord	
29/02/08 11:22	2	07.32.630 E	44.08.470 S	XBT	*57*	XBT	57	Largage	
29/02/08 12:29	2	07.29.900 E	44.12.900 S	N/A	N/A	OKTOPUS	3	Mise à l'eau	Vide
29/02/08 15:17	2	07.29.900 E	44.12.900 S	N/A	N/A	OKTOPUS	3	Mise à bord	
29/02/08 15:30	2	07.28.110 E	44.13.980 S	XBT	*58*	XBT	58	Largage	
29/02/08 16:30	2	07.23.170 E	44.19.810 S	Hydro	39	CTD	50	Mise à l'eau	
29/02/08 19:36	2	07.22.793 E	44.20.269 S	Hydro	39	CTD	50	Mise à bord	

29/02/08 21:35	2	07.18.000 E	44.25.420 S	XBT	*59*	XBT	59	Largage	
29/02/08 22:20	2	07.12.450 E	44.31.820 S	XBT	*60*	XBT	60	Largage	XBT fail at 103 m – redo
29/02/08 22:25	2	07.11.900 E	44.32.470 S	XBT	*61*	XBT	61	Largage	
29/02/08 23:20	2	07.08.090 E	44.36.720 S	Hydro	40	CTD	51	Mise à l'eau	
01/03/08 03:40	2	07.09.316 E	44.36.860 S	Hydro	40	CTD	51	Mise à bord	
01/03/08 07:45	2	06.57.760 E	44.42.330 S	XBT	*62*	XBT	62	Largage	Spike at 290m: redo
01/03/08 07:49	2	06.57.520 E	44.42.710 S	XBT	*63*	XBT	63	Largage	Spike: no data (wind)
01/03/08 09:43	2	06.54.100 E	44.46.660 S	XBT	*64*	XBT	64	Largage	Suspicious at 270m, spike at 675m
01/03/08 13:50	2	06.53.090 E	44.53.890 S	PROVOR	*4*	PROVOR	4	Largage	PV 613 (2000m)
01/03/08 14:59	2	06.53.070 E	44.53.880 S	Large	41	CTD	52	Mise à l'eau	Large3B Mixed Layer 0-300m
01/03/08 15:39	2	06.53.114 E	44.53.801 S	Large	41	CTD	52	Mise à bord	Large3B Mixed Layer 0-300m
01/03/08 16:22	2	06.53.030 E	44.53.900 S	Large	41	GOFLO	16	Mise à l'eau	Large3B TM's 0-2100m
01/03/08 19:17	2	06.54.204 E	44.53.205 S	Large	41	GOFLO	16	Mise à bord	Large3B TM's 0-2100m
01/03/08 19:56	2	06.53.140 E	44.53.770 S	Large	41	CTD	53	Mise à l'eau	Large3B Hydro 0-bottom
01/03/08 23:36	2	06.54.230 E	44.53.480 S	Large	41	CTD	53	Mise à bord	Large3B Hydro 0-bottom
02/03/08 00:56	2	06.53.130 E	44.53.740 S	Large	41	CTD	54	Mise à l'eau	Large3B PoTh 0-1000m
02/03/08 02:33	2	06.53.110 E	44.53.770 S	Large	41	CTD	54	Mise à bord	Large3B PoTh 0-1000m
02/03/08 03:34	2	06.45.380 E	45.02.470 S	XBT	*65*	XBT	65	Largage	
02/03/08 04:28	2	06.38.170 E	45.11.100 S	XBT	*66*	XBT	66	Largage	Spike at 270m, no data thereafter: redo
02/03/08 04:32	2	06.37.540 E	45.11.770 S	XBT	*67*	XBT	67	Largage	Spike at 200m, no data thereafter
02/03/08 05:38	2	06.30.090 E	45.19.770 S	Hydro	42	CTD	55	Mise à l'eau	
02/03/08 10:18	2	06.31.750 E	45.18.750 S	Hydro	42	CTD	55	Mise à bord	
02/03/08 12:59	2	06.24.920 E	45.25.170 S	XBT	*68*	XBT	68	Largage	
02/03/08 13:52	2	06.19.900 E	45.30.680 S	XBT	*69*	XBT	69	Largage	Spike at 150m: redo
02/03/08 14:00	2	06.19.130 E	45.31.460 S	XBT	*70*	XBT	70	Largage	
02/03/08 15:25	2	06.13.930 E	45.36.680 S	Hydro	43	CTD	56	Mise à l'eau	
02/03/08 18:54	2	06.14.716 E	45.37.309 S	Hydro	43	CTD	56	Mise à bord	
02/03/08 21:23	2	06.04.480 E	45.44.970 S	XBT	*71*	XBT	71	Largage	Spike at 590m
02/03/08 22:21	2	05:57.630 E	45.53.770 S	XBT	*72*	XBT	72	Largage	
02/03/08 23:47	2	05.51.890 E	46.01.450 S	Large	44	CTD	57	Mise à l'eau	Large4A 0-bottom
03/03/08 03:08	2	06.52.126 E	46.01.550 S	Large	44	CTD	57	Mise à bord	Large4A 0-bottom
03/03/08 04:08	2	05.51.639 E	46.01.378 S	Large	44	GOFLO	17	Mise à l'eau	Large4A TM's 0-2050m
03/03/08 07:10	2	05.52.650 E	46.00.850 S	Large	44	GOFLO	17	Mise à bord	Large4A TM's 0-2050m
03/03/08 07:38	2	05.52.390 E	46.01.010 S	Large	44	CTD	58	Mise à l'eau	Large4A Mixed Layer 0-200m
03/03/08 08:15	2	05.52.520 E	46.01.030 S	Large	44	CTD	58	Mise à bord	Large4A Mixed Layer 0-200m
03/03/08 08:30	2	05.51.610 E	46.01.450 S	PROVOR	*5*	PROVOR	5	Largage	PV 602 (2000m)

03/03/08 10:00	2	05.42.310 E	46.09.100 S	XBT	*73*	XBT	73	Largage	
03/03/08 11:39	2	05.32.650 E	46.21.390 S	Hydro	45	CTD	59	Mise à l'eau	
03/03/08 15:11	2	06.32.680 E	46.21.420 S	Hydro	45	CTD	59	Mise à bord	
03/03/08 16:08	2	05.27.040 E	46.27.450 S	XBT	*74*	XBT	74	Largage	Spike beyond 180m: redo
03/03/08 16:11	2	05.26.670 E	46.27.820 S	XBT	*75*	XBT	75	Largage	Spike at 200m
03/03/08 16:42	2	05.23.690 E	46.30.990 S	XBT	*76*	XBT	76	Largage	Spike at 260m: redo
03/03/08 16:47	2	05.23.130 E	46.31.540 S	XBT	*77*	XBT	77	Largage	Very suspicious data > 100m
03/03/08 16:57	2	05.22.040 E	46.32.640 S	XBT	*78*	XBT	78	Largage	Mini spikes at 402, 489 and 628m
03/03/08 18:34	2	05.11.830 E	46.43.310 S	Hydro	46	CTD	60	Mise à l'eau	
03/03/08 22:11	2	05.11.994 E	46.43.334 S	Hydro	46	CTD	60	Mise à bord	
03/03/08 23:18	2	05.04.140 E	46.51.080 S	XBT	*79*	XBT	79	Largage	
04/03/08 00:13	2	04.56.200 E	46.59.230 S	XBT	*80*	XBT	80	Largage	
04/03/08 01:28	2	04.47.490 E	47.08.320 S	Hydro	47	CTD	61	Mise à l'eau	
04/03/08 05:13	2	04.47.440 E	47.08.320 S	Hydro	47	CTD	61	Mise à bord	
04/03/08 06:09	2	04.39.330 E	47.16.360 S	XBT	*81*	XBT	81	Largage	
04/03/08 06:51	2	04.37.206 E	47.19.064 S	Super	48	OKTOPUS	4	Mise à l'eau	
04/03/08 09:57	2	04.37.204 E	47.19.062 S	Super	48	OKTOPUS	4	Mise à bord	Super3 Moins de 5cm sur une carotte
04/03/08 11:17	2	04.30.820 E	47.25.070 S	XBT	*82*	XBT	82	Largage	
04/03/08 12:35	2	04.22.610 E	47.33.160 S	Super	48	CTD	62	Mise à l'eau	Super3 Mixed Layer 0-250m
04/03/08 13:24	2	04.22.572 E	47.33.248 S	Super	48	CTD	62	Mise à bord	Super3 Mixed Layer 0-250m
04/03/08 13:59	2	04.22.621 E	47.33.267 S	Super	48	GOFLO	18	Mise à l'eau	Super3 Cd 0-200m
04/03/08 14:44	2	04.22.622 E	47.33.264 S	Super	48	GOFLO	18	Mise à bord	Super3 Cd 0-200m
04/03/08 15:00	2	04.22.610 E	47.33.260 S	Super	48	CTD	63	Mise à l'eau	Super3 Hydro 0-bottom
04/03/08 18:37	2	04.22.464 E	47.33.224 S	Super	48	CTD	63	Mise à bord	Super3 Hydro 0-bottom
04/03/08 19:00	2	04.22.362 E	47.33.166 S	Super	48	GOFLO	19	Mise à l'eau	Super3 Intercalibration Polarstern 0-3500m
04/03/08 22:50	2	04.22.370 E	47.33.160 S	Super	48	GOFLO	19	Mise à bord	Super3 Intercalibration Polarstern 0-3500m
04/03/08 23:30	2	04.22.330 E	47.33.151 S	Super	48	PIS	6	Mise à l'eau	Super3 Tracers 0-bottom
05/03/08 06:50	2	04.22.160 E	47.33.160 S	Super	48	PIS	6	Mise à bord	Super3 Tracers 0-bottom
05/03/08 07:07	2	04.22.332 E	47.33.156 S	Super	48	GOFLO	20	Mise à l'eau	Super3 TM's 1500-4000m
05/03/08 10:50	2	04.22.330 E	47.33.150 S	Super	48	GOFLO	20	Mise à bord	Super3 TM's 1500-4000m
05/03/08 11:08	2	04.22.100 E	47.32.720 S	Super	48	CTD	64	Mise à l'eau	Super3 REE 0-bottom
05/03/08 14:26	2	04.22.080 E	47.32.750 S	Super	48	CTD	64	Mise à bord	Super3 REE 0-bottom
05/03/08 14:40	2	04.22.226 E	47.33.065 S	Super	48	GOFLO	21	Mise à l'eau	Super3 TM's 0-1400m
05/03/08 16:01	2	04.22.388 E	47.33.181 S	Super	48	GOFLO	21	Mise à bord	Super3 TM's 0-1400m
05/03/08 16:36	2	04.22.450 E	47.33.230 S	Super	48	CTD	65	Mise à l'eau	Super3 234Th,210Po 0-1000m
05/03/08 17:56	2	04.22.540 E	47.33.290 S	Super	48	CTD	65	Mise à bord	Super3 234Th,210Po 0-1000m

05/03/08 18:07	2	04.22.543 E	47.33.293 S	Super	48	GOFLO	22	Mise à l'eau	Super3 Incub Fluo Max
05/03/08 19:01	2	04.22.141 E	47.33.261 S	Super	48	GOFLO	22	Mise à bord	Super3 Incub Fluo Max
05/03/08 19:30	2	04.22.961 E	47.33.047 S	Super	48	PIS	7	Mise à l'eau	Super3 Tracers 0-bottom
06/03/08 03:07	2	04.22.845 E	47.33.056 S	Super	48	PIS	7	Mise à bord	Super3 Tracers 0-bottom
06/03/08 03:45	2	04.22.600 E	47.33.360 S	Super	48	GOFLO	23	Mise à l'eau	Super3 Incub Fluo Max
06/03/08 04:15	2	04.22.604 E	47.33.368 S	Super	48	GOFLO	23	Mise à bord	Super3 Incub Fluo Max
06/03/08 04:26	2	04.22.480 E	47.33.310 S	Super	48	CTD	66	Mise à l'eau	Super3 Ba, 30Si, Ra 0-1000m
06/03/08 05:46	2	04.23.056 E	47.33.415 S	Super	48	CTD	66	Mise à bord	Super3 Ba, 30Si, Ra 0-1000m
06/03/08 06:00	2	04.22.960 E	47.33.320 S	Super	48	GOFLO	24	Mise à l'eau	Super3 Incub + TM Fluo Max
06/03/08 07:27	2	04.23.140 E	47.33.210 S	Super	48	GOFLO	24	Mise à bord	Super3 Incub + TM Fluo Max
06/03/08 07:44	2	04.22.440 E	47.33.820 S	PROVOR	*6*	PROVOR	6	Largage	PV 610 (2000m)
06/03/08 08:30	2	04.15.840 E	47.40.140 S	XBT	*83*	XBT	83	Largage	
06/03/08 09:14	2	04.08.490 E	47.47.100 S	XBT	*84*	XBT	84	Largage	
06/03/08 10:38	2	03.57.450 E	47.58.200 S	Hydro	49	CTD	67	Mise à l'eau	
06/03/08 14:20	2	03.57.410 E	47.58.235 S	Hydro	49	CTD	67	Mise à bord	
06/03/08 14:40	2	03.57.470 E	47.58.225 S	Hydro	49	OKTOPUS	5	Mise à l'eau	
06/03/08 17:20	2	03.57.472 E	47.58.228 S	Hydro	49	OKTOPUS	5	Mise à bord	Super3 Zero carotte
06/03/08 18:28	2	03.48.840 E	48.06.120 S	XBT	*85*	XBT	85	Largage	
06/03/08 19:19	2	03.40.520 E	48.14.150 S	XBT	*86*	XBT	86	Largage	
06/03/08 20:35	2	03.31.500 E	48.22.730 S	Hydro	50	CTD	68	Mise à l'eau	
06/03/08 23:59	2	03.31.457 E	48.22.733 S	Hydro	50	CTD	68	Mise à bord	
07/03/08 00:55	2	03.24.950 E	48.28.610 S	XBT	*87*	XBT	87	Largage	
07/03/08 01:51	2	03.16.650 E	48.36.470 S	XBT	*88*	XBT	88	Largage	
07/03/08 02:55	2	03.10.691 E	48.42.078 S	Hydro	51	CTD	69	Mise à l'eau	
07/03/08 06:03	2	03.10.858 E	48.42.190 S	Hydro	51	CTD	69	Mise à bord	
07/03/08 06:58	2	03.03.690 E	48.48.520 S	XBT	*89*	XBT	89	Largage	XBT fail: redo
07/03/08 07:05	2	03.02.560 E	48.49.470 S	XBT	*90*	XBT	90	Largage	
07/03/08 07:47	2	02.56.360 E	48.55.360 S	XBT	*91*	XBT	91	Largage	
07/03/08 08:59	2	02.49.940 E	49.01.690 S	Large	52	CTD	70	Mise à l'eau	Large5B 0-bottom
07/03/08 12:27	2	02.49.873 E	49.01.687 S	Large	52	CTD	70	Mise à bord	Large5B 0-bottom
07/03/08 13:59	2	02.49.920 E	49.01.680 S	Large	52	CTD	71	Mise à l'eau	Large5B Mixed Layer 0-250m
07/03/08 14:39	2	02.49.930 E	49.01.680 S	Large	52	CTD	71	Mise à bord	Large5B Mixed Layer 0-250m
07/03/08 14:53	2	02.49.926 E	49.01.690 S	Large	52	GOFLO	25	Mise à l'eau	Large5B TM's 0-2200m
07/03/08 17:55	2	02.49.928 E	49.01.694 S	Large	52	GOFLO	25	Mise à bord	Large5B TM's 0-2200m
07/03/08 18:28	2	02.49.930 E	49.01.690 S	Large	52	CTD	72	Mise à l'eau	Large5B Po,Ba,Si 0-1000m
07/03/08 19:44	2	02.49.874 E	49.01.678 S	Large	52	CTD	72	Mise à bord	Large5B Po,Ba,Si 0-1000m

07/03/08 19:55	2	02.49.390 E	49.01.680 S	PROVOR	*7*	PROVOR	7	Largage	PV 606 (2000m)
07/03/08 20:54	2	02.41.500 E	49.09.130 S	XBT	*92*	XBT	92	Largage	
07/03/08 21:25	2	02.36.480 E	49.13.700 S	XBT	*93*	XBT	93	Largage	
07/03/08 22:15	2	02.31.870 E	49.17.970 S	Hydro	53	CTD	73	Mise à l'eau	
08/03/08 01:39	2	02.32.006 E	49.18.062 S	Hydro	53	CTD	73	Mise à bord	
08/03/08 02:28	2	02.26.550 E	49.23.030 S	XBT	*94*	XBT	94	Largage	
08/03/08 03:16	2	02.19.330 E	49.28.910 S	XBT	*95*	XBT	95	Largage	
08/03/08 04:04	2	02.13.970 E	49.34.020 S	Hydro	54	CTD	74	Mise à l'eau	
08/03/08 07:06	2	02.14.192 E	49.34.100 S	Hydro	54	CTD	74	Mise à bord	
08/03/08 08:04	2	02.07.540 E	49.39.410 S	XBT	*96*	XBT	96	Largage	Spiking at 460m
08/03/08 08:41	2	02.01.730 E	49.44.560 S	XBT	*97*	XBT	97	Largage	Spiking at 600m
08/03/08 09:48	2	01.55.370 E	49.50.180 S	Hydro	55	CTD	75	Mise à l'eau	
08/03/08 13:02	2	01.57.890 E	49.48.360 S	Hydro	55	CTD	75	Mise à bord	
08/03/08 13:13	2	01.58.100 E	49.47.950 S	PROVOR	*8*	PROVOR	8	Largage	PV 616 (1550m)
08/03/08 16:08	2	01.48.410 E	49.55.940 S	XBT	*98*	XBT	98	Largage	
08/03/08 16:41	2	01.43.370 E	50.00.510 S	XBT	*99*	XBT	99	Largage	
08/03/08 17:34	2	01.36.590 E	50.06.320 S	Hydro	56	CTD	76	Mise à l'eau	
08/03/08 20:20	2	01.37.968 E	50.06.412 S	Hydro	56	CTD	76	Mise à bord	
08/03/08 21:07	2	01.32.530 E	50.10.600 S	XBT	*100*	XBT	100	Largage	
08/03/08 21:59	2	01.24.450 E	50.16.580 S	XBT	*101*	XBT	101	Largage	
08/03/08 23:12	2	01.18.130 E	50.22.360 S	Large	57	CTD	77	Mise à l'eau	Large6A 0-bottom
09/03/08 02:19	2	01.18.072 E	50.22.378 S	Large	57	CTD	77	Mise à bord	Large6A 0-bottom
09/03/08 02:50	2	01.19.535 E	50.22.551 S	Large	57	GOFLO	26	Mise à l'eau	Large6A TM's 0-2100m
09/03/08 05:12	2	01.19.971 E	50.22.611 S	Large	57	GOFLO	26	Mise à bord	Large6A TM's 0-2100m
09/03/08 05:34	2	01.18.930 E	50.22.480 S	Large	57	CTD	78	Mise à l'eau	Large6A Mixed Layer 0-250m
09/03/08 06:16	2	01.19.432 E	50.22.698 S	Large	57	CTD	78	Mise à bord	Large6A Mixed Layer 0-250m
09/03/08 06:58	2	01.13.420 E	50.27.070 S	XBT	*102*	XBT	102	Largage	
09/03/08 07:41	2	01.06.040 E	50.32.670 S	XBT	*103*	XBT	103	Largage	
09/03/08 08:38	2	00.58.540 E	50.38.350 S	Hydro	58	CTD	79	Mise à l'eau	
09/03/08 11:20	2	00.58.621 E	50.38.489 S	Hydro	58	CTD	79	Mise à bord	
09/03/08 11:32	2	00.58.210 E	50.37.940 S	PROVOR	*9*	PROVOR	9	Largage	PV 611 (1550m)
09/03/08 13:05	2	00.42.540 E	50.43.460 S	XBT	*104*	XBT	104	Largage	
09/03/08 13:48	2	00.41.170 E	50.48.580 S	XBT	*105*	XBT	105	Largage	
09/03/08 14:25	2	00.39.400 E	50.54.210 S	Hydro	59	CTD	80	Mise à l'eau	
09/03/08 16:22	2	00.39.350 E	50.54.242 S	Hydro	59	CTD	80	Mise à bord	
09/03/08 17:39	2	00.29.000 E	51.02.420 S	XBT	*106*	XBT	106	Largage	Spikes from 200m: redo

09/03/08 17:47	2	00.27.770 E	51.03.440 S	XBT	*107*	XBT	107	Largage	Spikes from 300m: redo
09/03/08 17:52	2	00.27.080 E	51.04.030 S	XBT	*108*	XBT	108	Largage	
09/03/08 18:56	2	00.19.870 E	51.10.080 S	Hydro	60	CTD	81	Mise à l'eau	
09/03/08 20:44	2	00.19.945 E	51.10.286 S	Hydro	60	CTD	81	Mise à bord	
09/03/08 21:59	2	00.11.340 E	51.16.980 S	XBT	*109*	XBT	109	Largage	Spikes from 280m: redo
09/03/08 22:06	2	00.10.460 E	51.17.650 S	XBT	*110*	XBT	110	Largage	Miniature spike at 472m
09/03/08 23:57	2	00.00.620 E	51.25.820 S	Hydro	61	CTD	82	Mise à l'eau	
10/03/08 02:25	2	00.00.493 E	51.25.817 S	Hydro	61	CTD	82	Mise à bord	
10/03/08 03:36	2	00.00.290 E	51.33.870 S	XBT	*111*	XBT	111	Largage	
10/03/08 04:47	2	00.00.360 E	51.42.640 S	XBT	*112*	XBT	112	Largage	Spikes from 350m
10/03/08 05:50	2	00.00.040 E	51.50.870 S	Super	62	CTD	83	Mise à l'eau	Super4 Mixed Layer 0-250m
10/03/08 06:29	2	00.00.040 E	51.50.870 S	Super	62	CTD	83	Mise à bord	Super4 Mixed Layer 0-250m
10/03/08 07:03	2	00.00.087 E	51.51.236 S	Super	62	GOFLO	27	Mise à l'eau	Super4 Cd + Incubation (Pedro) 0-200m
10/03/08 08:10	2	00.00.378 E	51.51.297 S	Super	62	GOFLO	27	Mise à bord	Super4 Cd + Incubation (Pedro) 0-200m
10/03/08 08:34	2	00.00.041 E	51.51.350 S	Super	62	CTD	84	Mise à l'eau	Super4 Hydro 0-bottom
10/03/08 10:44	2	00.01.030 E	51.52.420 S	Super	62	CTD	84	Mise à bord	Super4 Hydro 0-bottom
10/03/08 11:15	2	00.00.307 E	51.51.082 S	Super	62	GOFLO	28	Mise à l'eau	Super4 TM's during day 0-1000m
10/03/08 13:06	2	00.00.478 E	51.51.241 S	Super	62	GOFLO	28	Mise à bord	Super4 TM's during day 0-1000m
10/03/08 13:40	2	00.00.00 E	51.51.330 S	Super	62	PIS	8	Mise à l'eau	Super4 Tracers 0-bottom
10/03/08 20:30	2	00.00.00 E	51.51.330 S	Super	62	PIS	8	Mise à bord	Super4 Tracers 0-bottom
10/03/08 20:42	2	00.00.043 E	51.51.400 S	Super	62	CTD	85	Mise à l'eau	Super4 REE 0-bottom
10/03/08 22:38	2	00.00.724W	51.51.467 S	Super	62	CTD	85	Mise à bord	Super4 REE 0-bottom
11/03/08 00:05	2	00.00.140 E	51.51.890 S	Super	62	GOFLO	29	Mise à l'eau	Super4 Incubation (Geraldine) Fluo max
11/03/08 01:15	2	00.00.095 E	51.51.899 S	Super	62	GOFLO	29	Mise à bord	Super4 Incubation (Geraldine) Fluo max
11/03/08 01:30	2	00.00.137 W	51.51.900 S	Super	62	CTD	86	Mise à l'eau	Super4 234Th,210Po,Ra 0-1000m
11/03/08 02:48	2	00.00.109 W	51.52.158 S	Super	62	CTD	86	Mise à bord	Super4 234Th,210Po,Ra 0-1000m
11/03/08 03:15	2	00.00.260 E	51.52.190 S	Super	62	GOFLO	30	Mise à l'eau	Super4 Incubation (Bron) Fluo max
11/03/08 04:18	2	00.00.480 E	51.52.440 S	Super	62	GOFLO	30	Mise à bord	Super4 Incubation (Bron) Fluo max
11/03/08 04:27	2	00.00.410 E	51.52.540 S	Super	62	CTD	87	Mise à l'eau	Super4 Ba, 30Si 0-1000m
11/03/08 05:58	2	00.00.328 E	51.52.864 S	Super	62	CTD	87	Mise à bord	Super4 Ba, 30Si 0-1000m
11/03/08 06:20	2	00.00.320 E	51.52.700 S	Super	62	GOFLO	31	Mise à l'eau	Super4 TM's deep 1000-2400m
11/03/08 09:04	2	00.00.230 E	51.52.911 S	Super	62	GOFLO	31	Mise à bord	Super4 TM's deep 1000-2400m
11/03/08 09:28	2	00.00.00 E	51.51.330 S	Super	62	PIS	9	Mise à l'eau	Super4 Tracers 0-bottom
11/03/08 15:49	2	00.00.00 E	51.51.330 S	Super	62	PIS	9	Mise à bord	Super4 Tracers 0-bottom
11/03/08 16:20	2	00.00.300 E	51.53.280 S	Super	62	GOFLO	32	Mise à l'eau	Super4 Fe isotopes Fluo max
11/03/08 18:00	2	00.00.220 E	51.53.120 S	Super	62	GOFLO	32	Mise à bord	Super4 Fe isotopes Fluo max

11/03/08 18:35	2	00.00.130 E	51.52.960 S	Super	62	OKTOPUS	6	Mise à l'eau	
11/03/08 20:21	2	00.00.132 E	51.52.940 S	Super	62	OKTOPUS	6	Mise à bord	Super4 Zero carotte
11/03/08 20:41	2	00.00.070 E	51.59.290 S	PROVOR	*10*	PROVOR	10	Largage	PV 603 (1550m)
11/03/08 21:45	2	00.00.040 E	52.06.280 S	XBT	*113*	XBT	113	Largage	Miniatures spikes at 635m
11/03/08 22:50	2	00.00.106 E	52.16.379 S	Hydro	63	CTD	88	Mise à l'eau	
12/03/08 01:22	2	00.00.090 E	52.16.382 S	Hydro	63	CTD	88	Mise à bord	
12/03/08 02:24	2	00.00.310 E	52.25.810 S	XBT	*114*	XBT	114	Largage	Miniatures spikes at 767m
12/03/08 03:57	2	00.00.090 E	52.36.080 S	Hydro	64	CTD	89	Mise à l'eau	
12/03/08 06:18	2	00.00.012 E	52.36.144 S	Hydro	64	CTD	89	Mise à bord	
12/03/08 06:30	2	00.00.330 E	52.36.620 S	PROVOR	*11*	PROVOR	11	Largage	PV 605 (1550m)
12/03/08 07:27	2	00.00.300 W	52.46.680 S	XBT	*115*	XBT	115	Largage	Spike at 660m
12/03/08 08:39	2	00.00.019 E	52.55.822 S	Hydro	65	CTD	90	Mise à l'eau	
12/03/08 10:56	2	00.00.013 E	52.55.798 S	Hydro	65	CTD	90	Mise à bord	
12/03/08 12:24	2	00.00.031 E	52.58.906 S	Hydro	65	CTD	91	Mise à l'eau	Intercalibration Polarstern REE
12/03/08 13:35	2	00.00.020 E	52.58.913 S	Hydro	65	CTD	91	Mise à bord	Intercalibration Polarstern REE
12/03/08 14:28	2	00.01.830 W	53.04.480 S	XBT	*116*	XBT	116	Largage	
12/03/08 15:02	2	00.00.760 E	53.11.300 S	XBT	*117*	XBT	117	Largage	
12/03/08 15:48	2	00.00.140 E	53.15.620 S	Hydro	66	CTD	92	Mise à l'eau	
12/03/08 17:39	2	00.00.040 E	53.15.650 S	Hydro	66	CTD	92	Mise à bord	
12/03/08 18:19	2	00.00.030 E	53.20.760 S	XBT	*118*	XBT	118	Largage	
12/03/08 19:11	2	00.00.000 E	53.30.720 S	XBT	*119*	XBT	119	Largage	
12/03/08 19:53	2	00.00.160 E	53.35.515 S	Hydro	67	CTD	93	Mise à l'eau	
12/03/08 22:08	2	00.00.310 W	53.35.630 S	PROVOR	*12*	PROVOR	12	Largage	PV 601 (1550m)
12/03/08 22:13	2	00.00.040 W	53.35.520 S	Hydro	67	CTD	93	Mise à bord	
12/03/08 23:36	2	00.00.050 W	53.44.830 S	XBT	*120*	XBT	120	Largage	
13/03/08 00:46	2	00.00.100 E	53.55.130 S	Hydro	68	CTD	94	Mise à l'eau	
13/03/08 02:53	2	00.00.035 E	53.55.150 S	Hydro	68	CTD	94	Mise à bord	
13/03/08 04:28	2	00.00.010 E	54.05.470 S	XBT	*121*	XBT	121	Largage	Spiking at 140m: redo
13/03/08 04:34	2	00.00.020 E	54.06.210 S	XBT	*122*	XBT	122	Largage	
13/03/08 05:25	2	00.00.030 E	54.15.000 S	Hydro	69	CTD	95	Mise à l'eau	
13/03/08 07:34	2	00.00.037 W	54.15.043 S	Hydro	69	CTD	95	Mise à bord	
13/03/08 08:38	2	00.00.200 W	54.25.900 S	XBT	*123*	XBT	123	Largage	
13/03/08 09:36	2	00.00.042 W	54.34.828 S	Hydro	70	CTD	96	Mise à l'eau	
13/03/08 10:54	2	00.00.030 W	54.34.829 S	Hydro	70	CTD	96	Mise à bord	
13/03/08 12:21	2	00.01.730 W	54.50.070 S	XBT	*124*	XBT	124	Largage	
13/03/08 13:00	2	00.00.029 E	54.54.760 S	Hydro	71	CTD	97	Mise à l'eau	

13/03/08 14:25	2	00.00.241 E	54.54.787 S	Hydro	71	CTD	97	Mise à bord	
13/03/08 15:24	2	00.00.010 E	55.04.780 S	XBT	*125*	XBT	125	Largage	
13/03/08 18:42	2	00.01.380 E	55.13.847 S	Large	72	CTD	98	Mise à l'eau	Large7A 0-bottom
13/03/08 20:40	2	00.01.655 E	55.13.703 S	Large	72	CTD	98	Mise à bord	Large7A 0-bottom
13/03/08 21:08	2	00.02.214 E	55.14.071 S	Large	72	GOFLO	33	Mise à l'eau	Large7A TM's 0-2100m
13/03/08 23:50	2	00.02.662 E	55.13.940 S	Large	72	GOFLO	33	Mise à bord	Large7A TM's 0-2100m
14/03/08 00:10	2	00.02.660 E	55.13.930 S	Large	72	CTD	99	Mise à l'eau	Large7A Ba, 30Si, Po 0-1000m
14/03/08 01:42	2	00.02.611 E	55.13.948 S	Large	72	CTD	99	Mise à bord	Large7A Ba, 30Si, Po 0-1000m
14/03/08 04:24	2	00.00.920 E	55.24.090 S	XBT	*126*	XBT	126	Largage	
14/03/08 06:09	2	00.00.021 W	55.34.140 S	Large	73	CTD	100	Mise à l'eau	Large7A Mixed Layer 0-250m
14/03/08 06:47	2	00.00.021W	55.34.140 S	Large	73	CTD	100	Mise à bord	Large7A Mixed Layer 0-250m
14/03/08 08:14	2	00.00.274 E	55.34.219 S	Hydro	73	CTD	101	Mise à l'eau	
14/03/08 10:57	2	00.00.330 E	55.34.230 S	Hydro	73	CTD	101	Mise à bord	
14/03/08 11:15	2	00.00.120 E	53.34.240 S	PROVOR	*13*	PROVOR	13	Largage	PV 609 (1550m)
14/03/08 12:25	2	00.01.690 E	55.44.750 S	XBT	*127*	XBT	127	Largage	Spike at 645m
14/03/08 13:51	2	00.06.790 E	55.54.260 S	Hydro	74	CTD	102	Mise à l'eau	
14/03/08 16:32	2	00.06.877 E	55.54.331 S	Hydro	74	CTD	102	Mise à bord	
14/03/08 17:53	2	00.06.120 E	56.04.310 S	XBT	*128*	XBT	128	Largage	
14/03/08 19:42	2	00.00.850 E	56.13.975 S	Hydro	75	CTD	103	Mise à l'eau	
14/03/08 22:48	2	00.00.469 E	56.13.926 S	Hydro	75	CTD	103	Mise à bord	
15/03/08 01:20	2	00.10.750 E	56.23.970 S	XBT	*129*	XBT	129	Largage	
15/03/08 03:29	2	00.07.330 E	56.33.490 S	XBT	*130*	XBT	130	Largage	
15/03/08 06:20	2	00.00.852 W	56.45.736 S	Hydro	76	CTD	104	Mise à l'eau	
15/03/08 09:07	2	00.00.854 W	56.45.739 S	Hydro	76	CTD	104	Mise à bord	
15/03/08 10:11	2	00.02.390 W	56.56.970 S	XBT	*131*	XBT	131	Largage	
15/03/08 11:45	2	00.06.800 W	57.12.740 S	Hydro	77	CTD	105	Mise à l'eau	
15/03/08 15:02	2	00.06.865 W	57.12.703 S	Hydro	77	CTD	105	Mise à bord	
15/03/08 16:02	2	00.03.840 W	57.23.840 S	XBT	*132*	XBT	132	Largage	
15/03/08 16:52	2	00.02.190 W	57.33.150 S	Super	78	CTD	106	Mise à l'eau	Super5 Hydro 0-bottom
15/03/08 19:42	2	00.02.256 W	57.33.138 S	Super	78	CTD	106	Mise à bord	Super5 Hydro 0-bottom
15/03/08 20:30	2	00.02.190 W	57.33.150 S	Super	78	GOFLO	34	Mise à l'eau	Super5 TM's deep 1000-bottom
15/03/08 23:20	2	00.02.190 W	57.33.150 S	Super	78	GOFLO	34	Mise à bord	Super5 TM's deep 1000-bottom
15/03/08 23:57	2	00.02.190 W	57.33.150 S	Super	78	CTD	107	Mise à l'eau	Super5 REE 0-bottom
16/03/08 02:54	2	00.02.180 W	57.33.140 S	Super	78	CTD	107	Mise à bord	Super5 REE 0-bottom
16/03/08 03:40	2	00.02.190 W	57.33.139 S	Super	78	GOFLO	35	Mise à l'eau	Super5 Cd + Incubation (Pedro) 0-200m
16/03/08 04:30	2	00.02.190 W	57.33.139 S	Super	78	GOFLO	35	Mise à bord	Super5 Cd + Incubation (Pedro) 0-200m

16/03/08 07:27	2	00.02.252 W	57.33.161 S	Super	78	CTD	108	Mise à l'eau	Super5 Mixed Layer 0-270m
16/03/08 07:58	2	00.02.251 W	57.33.156 S	Super	78	CTD	108	Mise à bord	Super5 Mixed Layer 0-270m
16/03/08 08:05	2	00.02.192 W	57.33.137 S	Super	78	PIS	10	Mise à l'eau	Super5 Tracers 0-bottom
16/03/08 15:20	2	00.02.193 W	57.33.139 S	Super	78	PIS	10	Mise à bord	Super5 Tracers 0-bottom
16/03/08 15:43	2	00.02.191 W	57.33.140 S	Super	78	GOFLO	36	Mise à l'eau	Super5 TM's during day 0-1000m
16/03/08 17:20	2	00.02.193 W	57.33.154 S	Super	78	GOFLO	36	Mise à bord	Super5 TM's during day 0-1000m
16/03/08 17:30	2	00.02.190 W	57.33.150 S	Super	78	CTD	109	Mise à l'eau	Super5 234Th,210Po,Ra 0-1000m
16/03/08 18:44	2	00.02.270 W	57.33.150 S	Super	78	CTD	109	Mise à bord	Super5 234Th,210Po,Ra 0-1000m
16/03/08 19:20	2	00.02.193 W	57.33.143 S	Super	78	GOFLO	37	Mise à l'eau	Super5 Fe isotopes 0-1000m
16/03/08 21:34	2	00.02.190 W	57.33.140 S	Super	78	GOFLO	37	Mise à bord	Super5 Fe isotopes 0-1000m
16/03/08 21:57	2	00.02.268 W	57.33.152 S	Super	78	CTD	110	Mise à l'eau	Super5 Ba, 30Si 0-1000m
16/03/08 23:00	2	00.02.264 W	57.33.140 S	Super	78	CTD	110	Mise à bord	Super5 Ba, 30Si 0-1000m
17/03/08 00:15	2	00.03.021 W	57.33.084 S	Super	78	PIS	11	Mise à l'eau	Super5 Tracers 0-bottom
17/03/08 07:55	2	00.03.049 W	57.33.080 S	Super	78	PIS	11	Mise à bord	Super5 Tracers 0-bottom
17/03/08 08:02	2	00.03.048 W	57.33.040 S	Super	78	GOFLO	38	Mise à l'eau	Super5 Large Volume clean water Surface
17/03/08 08:50	2	00.03.049 W	57.33.040 S	Super	78	GOFLO	38	Mise à bord	Super5 Large Volume clean water Surface
17/03/08 09:07	2	00.02.571 W	57.32.726 S	Super	78	OKTOPUS	7	Mise à l'eau	
17/03/08 11:42	2	00.02.525 W	57.32.715 S	Super	78	OKTOPUS	7	Mise à bord	Super5: 2 carottes (sur 8)
17/03/08 12:11	2	00.01.830 W	57.32.100 S	XBT	*133*	XBT	133	Largage	Sebaastian's BirthDay!
18/03/08 18:22	2	05.49.140 E	52.56.840 S	PROVOR	*14*	PROVOR	14	Largage	PV S2 472 (2000m)
19/03/08 07:40	2	09.14.690 E	50.38.980 S	PROVOR	*15*	PROVOR	15	Largage	PV S2 347 (2000m)
19/03/08 15:54	2	11.13.740 E	49.15.810 S	PROVOR	*16*	PROVOR	16	Largage	PV S2 410 (2000m)
20/03/08 11:25	2	22.03.460 E	41.56.840 S	PROVOR	*17*	PROVOR	17	Largage	PV S3 615 (2000m)
21/03/08 04:59	2	20.38.170 E	42.59.520 S	XBT	*134*	XBT	134	Largage	
21/03/08 06:05	2	20.54.610 E	42.49.100 S	XBT	*135*	XBT	135	Largage	
21/03/08 07:03	2	21.09.120 E	42.40.150 S	XBT	*136*	XBT	136	Largage	
21/03/08 08:07	2	21.24.850 E	42.30.350 S	XBT	*137*	XBT	137	Largage	
21/03/08 09:26	2	21.44.470 E	42.18.160 S	XBT	*138*	XBT	138	Largage	
21/03/08 11:43	2	22.05.460 E	41.53.870 S	XBT	*139*	XBT	139	Largage	
21/03/08 12:38	2	22.13.440 E	41.42.590 S	XBT	*140*	XBT	140	Largage	
21/03/08 13:37	2	22.21.250 E	41.30.510 S	XBT	*141*	XBT	141	Largage	
21/03/08 14:40	2	22.29.730 E	41.17.400 S	XBT	*142*	XBT	142	Largage	

1-B “ATMOSPHERE” OPERATIONS - RADIOSONDE LAUNCHES

See Chapter in cruise report : “Atmospheric and Air Sea physical on board observations”.

(2) INVENTORY OF THE SAMPLES COLLECTED FOR EACH INSTRUMENT

At each station all the types of sampled parameters, the associated sampled depths and the associated sampled volumes have been accurately recorded.

Some of the documents are in the appendix of this report and all of them will be available soon on the BGH database website (CYBER) with restricted access in the “basic files” category.

CTD rosette (in Appendix 1: CTD casts)

- Rosette log:
  See “CTD Casts – CTD bottles values- (filename:bgh000-110_rosette_btl.xls)
- Bottle log (with the bottle depths):
  See “CTD Casts – bottle depths-” (filename: bgh000-110_depths_btl.xls)
- Water sampling data sheets for the 79 geographical stations (111 CTDs):
  See “CTD Casts – samplings- (filenames: Prelevement_*casttype*_CTD*number*.xls)

In appendixes you will find main references for In Situ Pumps and GoFlo

- ISP log (appendix 2)
- GoFlo log (appendix 3)

For information on the other instruments and parameters, please refer to the individual reports and appendixes provided by each scientist.

(3) THE DATABASE DICTIONARY

The purpose of this dictionary is to describe all the parameters acquired during the cruise, as well as the several types of instruments, for which measurements and sampling were carried out on station and underway.

Below a simplified version of the dictionary (a complete version can be found in the corresponding appendix)

Niskin-frame sampling

Rosette Cast	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
Hydro	Sal	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr
	O2	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr
	O2/Ar	Michael Bender bender@Princeton.EDU, Nicolas Cassar ncassar@Princeton.EDU	Pedro Monteiro, pmonteir@csir.co.za	ncassar@Princeton.EDU
	CFC	Rana Fine, rfine@rsmas.miami.edu	Rana Fine, rfine@rsmas.miami.edu	rfine@rsmas.miami.edu
	DIC Licor	Bruno Delille, Bruno.Delille@ulg.ac.be	Bruno Delille & Nicolas-Xavier Geilfus, Bruno.Delille@ulg.ac.be & nxgeilfus@ulg.ac.be	Bruno.Delille@ulg.ac.be
	Alk & pH	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	mgonzalez@dqui.ulpgc.es
	DIC colori	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	mgonzalez@dqui.ulpgc.es
	Pigm	Hervé Claustre, herve.claustre@obs-vlfr.fr	Joséphine Ras, jras@obs-vlfr.fr	jras@obs-vlfr.fr
	NO3 & Si	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	Marie.boye@univ-brest.fr
	PO4	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	marie.boye@univ-brest.fr
	NH4	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	marie.boye@univ-brest.fr
	Chloro	M. Boye, marie.boye@univ-brest.fr	A. Gueneugues, Audrey.Gueneugues@univ-brest.fr	marie.boye@univ-brest.fr

	BSi	R. Corvaisier, rudolph.corvaisier@univ-brest.fr/P. Pondaven, philippe.pondaven@univ-brest.fr	R. Corvaisier, rudolph.corvaisier@univ-brest.fr/E. Grossteffan, emilie.grossteffan@univ-brest.fr	rudolph.corvaisier@univ-brest.fr
	Taxo	M. Boye, marie.boye@univ-brest.fr	B. Beker, beatriz.beker@univ-brest.fr	beatriz.beker@univ-brest.fr
	Cocco	L. Beaufort, beaufort@cerege.fr		beaufort@cerege.fr
	POC/PIC/PON	M. Boye, marie.boye@univ-brest.fr	A. Masson, annick.masson@univ-brest.fr	annick.masson@univ-brest.fr
	Bore	Eric Douville	Eric Douville	
	dBa	F. Dehairs fdehairs@vub.ac.be		fdehairs@vub.ac.be
	234Th	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
	Bacterio	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	brnkir001@uct.ac.za/ kirstb007@gmail.com
	Octopus	E. Viollier, E.Viollier viollier@ipgp.jussieu.fr	E. Viollier, E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr
Hydro Large	Sal	Sabrina.speich@univ-brest.fr	Sabrina.speich@univ-brest.fr	Sabrina.speich@univ-brest.fr
	O2	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr
	O2/Ar	Michael Bender bender@Princeton.EDU, Nicolas Cassar ncassar@Princeton.EDU	Pedro Monteiro, pmonteir@csir.co.za	ncassar@Princeton.EDU
	CFC	Rana Fine, rfine@rsmas.miami.edu	Rana Fine, rfine@rsmas.miami.edu	rfine@rsmas.miami.edu
	DIC Licor	Bruno Delille, Bruno.Delille@ulg.ac.be	Bruno Delille & Nicolas-Xavier Geilfus, Bruno.Delille@ulg.ac.be & nxgeilfus@ulg.ac.be	Bruno.Delille@ulg.ac.be
	Alk & pH	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	mgonzalez@dqui.ulpgc.es
	DIC colori	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	mgonzalez@dqui.ulpgc.es

	NO3 & Si	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	Marie.boye@univ-brest.fr
	PO4	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	marie.boye@univ-brest.fr
	Bore	Eric Douville (LSCE)	Eric Douville	eric.douville@lsce.ipsl.fr
	dBa	F. Dehairs fdehairs@vub.ac.be		fdehairs@vub.ac.be
	d30Si	D. Cardinal damien.cardinal@africamuseum.be F. Fripiat ffripiat@africamuseum.be	F. Fripiat ffripiat@africamuseum.be D. Cardinal damien.cardinal@africamuseum.be	damien.cardinal@africamuseum.be ffripiat@africamuseum.be
	Bsi	R. Corvaisier, rudolph.corvaisier@univ-brest.fr/P. Pondaven, philippe.pondaven@univ-brest.fr	R. Corvaisier, rudolph.corvaisier@univ-brest.fr/E. Grossteffan, emilie.grossteffan@univ-brest.fr	rudolph.corvaisier@univ-brest.fr
	Cocco	L. Beaufort, beaufort@cerege.fr		beaufort@cerege.fr
	Taxo	M. Boye, marie.boye@univ-brest.fr	B. Beker, beatriz.beker@univ-brest.fr	beatriz.beker@univ-brest.fr
	234Th	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
Hydro Super	Sal	Sabrina.speich@univ-brest.fr	Sabrina.speich@univ-brest.fr	Sabrina.speich@univ-brest.fr
	O2	Sabrina.speich@univ-brest.fr	Sabrina.speich@univ-brest.fr	Sabrina.speich@univ-brest.fr
	CFC	Rana Fine, rfine@rsmas.miami.edu	Rana Fine, rfine@rsmas.miami.edu	rfine@rsmas.miami.edu
	DIC Licor	Bruno Delille, Bruno.Delille@ulg.ac.be	Bruno Delille & Nicolas-Xavier Geilfus, Bruno.Delille@ulg.ac.be & nxgeilfus@ulg.ac.be	Bruno.Delille@ulg.ac.be
	Alk & pH	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	mgonzalez@dqui.ulpgc.es
	DIC colori	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	mgonzalez@dqui.ulpgc.es

	14C POC & DOC	Nadine Tisnerat-Laborde, Nadine.Tisnerat@lsce.cnrs-gif.fr	Nadine Tisnerat-Laborde, Nadine.Tisnerat@lsce.cnrs-gif.fr	Nadine.Tisnerat@lsce.cnrs-gif.fr
	14C DIC	Nadine Tisnerat-Laborde, Nadine.Tisnerat@lsce.cnrs-gif.fr	Nadine Tisnerat-Laborde, Nadine.Tisnerat@lsce.cnrs-gif.fr	Nadine.Tisnerat@lsce.cnrs-gif.fr
	NO3 & Si	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	Marie.boye@univ-brest.fr
	PO4	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	marie.boye@univ-brest.fr
	Bore	Eric Douville	Eric Douville	
	dBa	F. Dehairs fdehairs@vub.ac.be	F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
	d30Si	D. Cardinal damien.cardinal@africamuseum.be F. Fripiat ffripiat@africamuseum.be	F. Fripiat ffripiat@africamuseum.be D. Cardinal damien.cardinal@africamuseum.be	damien.cardinal@africamuseum.be ffripiat@africamuseum.be
	BSi	R. Corvaisier, rudolph.corvaisier@univ-brest.fr/P. Pondaven, philippe.pondaven@univ-brest.fr	R. Corvaisier, rudolph.corvaisier@univ-brest.fr/E. Grossteffan, emilie.grossteffan@univ-brest.fr	rudolph.corvaisier@univ-brest.fr
	Octopus	E. Viollier, E.Viollier viollier@ipgp.jussieu.fr	E. Viollier, E.Viollier viollier@ipgp.jussieu.fr	E. Viollier, E.Viollier viollier@ipgp.jussieu.fr
ML Large	O2	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr
	O2/Ar	Michael Bender bender@Princeton.EDU, Nicolas Cassar ncassar@Princeton.EDU	Pedro Monteiro, pmonteir@csir.co.za	ncassar@Princeton.EDU
	DOC	Richard Sempéré, sempere@com.univ-mrs.fr	Bruno Charrière, bruno.charriere@com.univ-mrs.fr	sempere@com.univ-mrs.fr
	Pigm	Hervé Claustre, herve.claustre@obs-vlfr.fr	Joséphine Ras, jras@obs-vlfr.fr	jras@obs-vlfr.fr
	Chloro	M. Boye, marie.boye@univ-brest.fr	A. Gueneugues, Audrey.Gueneugues@univ-brest.fr	marie.boye@univ-brest.fr
	Inc 15N & 13C	Pedro Monteiro pmonteir@csir.co.za, Howard Waldron howard.waldron@uct.ac.za	Howard Waldron howard.waldron@uct.ac.za, Sandy Thomalla sandy_thomalla@yahoo.com, Warren Joubert wjoubert@csir.co.za	pmonteir@csir.co.za

	NO3 & Si	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	Marie.boye@univ-brest.fr
	PO4	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	marie.boye@univ-brest.fr
	NH4	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	marie.boye@univ-brest.fr
	POC/PIC/PON	M. Boye, marie.boye@univ-brest.fr	A. Masson, annick.masson@univ-brest.fr	annick.masson@univ-brest.fr
	Taxo	M. Boye, marie.boye@univ-brest.fr	B. Beker, beatriz.beker@univ-brest.fr	beatriz.beker@univ-brest.fr
	Cocco	L. Beaufort, beaufort@cerege.fr		beaufort@cerege.fr
	inc Si	R. Corvaisier, rudolph.corvaisier@univ-brest.fr/P. Pondaven, philippe.pondaven@univ-brest.fr	R. Corvaisier, rudolph.corvaisier@univ-brest.fr/E. Grossteffan, emilie.grossteffan@univ-brest.fr	rudolph.corvaisier@univ-brest.fr
	234Th	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
ML Super	O2	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr
	O2/Ar	Michael Bender bender@Princeton.EDU, Nicolas Cassar ncassar@Princeton.EDU	Pedro Monteiro, pmonteir@csir.co.za	ncassar@Princeton.EDU
	DOC	Richard Sempéré, sempere@com.univ-mrs.fr	Bruno Charrière, bruno.charriere@com.univ-mrs.fr	sempere@com.univ-mrs.fr
	Pigm	Hervé Claustre, herve.claustre@obs-vlfr.fr	Joséphine Ras, jras@obs-vlfr.fr	jras@obs-vlfr.fr
	Chloro	M. Boye, marie.boye@univ-brest.fr	A. Gueneugues, Audrey.Gueneugues@univ-brest.fr	marie.boye@univ-brest.fr
	Inc 15N & 13C	Pedro Monteiro pmonteir@csir.co.za, Howard Waldron howard.waldron@uct.ac.za	Howard Waldron howard.waldron@uct.ac.za, Sandy Thomalla sandy_thomalla@yahoo.com, Warren Joubert wjoubert@csir.co.za	pmonteir@csir.co.za

	NO3 & Si	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	Marie.boye@univ-brest.fr
	PO4	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	marie.boye@univ-brest.fr
	NH4	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	marie.boye@univ-brest.fr
	Taxo	M. Boye, marie.boye@univ-brest.fr	B. Beker, beatriz.beker@univ-brest.fr	beatriz.beker@univ-brest.fr
	Cocco	L. Beaufort, beaufort@cerege.fr		beaufort@cerege.fr
	POC/PIC/PON	M. Boye, marie.boye@univ-brest.fr	A. Masson, annick.masson@univ-brest.fr	annick.masson@univ-brest.fr
	inc Si D+R	R. Corvaisier, rudolph.corvaisier@univ-brest.fr/P. Pondaven, philippe.pondaven@univ-brest.fr D. Cardinal dcardinal@africamuseum.be F. Fripiat ffripiat@africamuseum.be	R. Corvaisier, rudolph.corvaisier@univ-brest.fr/E. Grossteffan, emilie.grossteffan@univ-brest.fr F. Fripiat ffripiat@africamuseum.be	rudolph.corvaisier@univ-brest.fr, ffripiat@africamuseum.be
	inc Si D	D. Cardinal dcardinal@africamuseum.be F. Fripiat ffripiat@africamuseum.be R. Corvaisier, rudolph.corvaisier@univ-brest.fr	F. Fripiat ffripiat@africamuseum.be R. Corvaisier, rudolph.corvaisier@univ-brest.fr/E. Grossteffan, emilie.grossteffan@univ-brest.fr	ffripiat@africamuseum.be rudolph.corvaisier@univ-brest.fr,
PoTh Large & Super	Sal	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr
	NO3 & Si	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	Marie.boye@univ-brest.fr
	210Po	P. Masquè Pere.Masque@uab.es	E. Verdeny Elisabet.Verdeny@uab.cat , N. Escuberta Nuria.casacuberta@uab.cat	Elisabet.Verdeny@uab.cat
	234Th	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
	226Ra	C. Hanfland, chanfland@awi-bremerhaven.de		chanfland@awi-bremerhaven.de

	Ba	F. Dehairs fdehairs@vub.ac.be, D. Cardinal dcardinal@africamuseum.be	D. Cardinal dcardinal@africamuseum.be	fdehairs@vub.ac.be, dcardinal@africamuseum.be
	Bacterio	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	brnkir001@uct.ac.za/ kirstb007@gmail.com
BaSi Large & Super	Sal	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr
	NO3 & Si	M. Boye, marie.boye@univ-brest.fr	F. Le Moigne, fred.le.moigne@wanadoo.fr/A. Masson, Annick.Masson@univ-brest.fr	marie.boye@univ-brest.fr
	O2	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr
	dBa	F. Dehairs fdehairs@vub.ac.be	F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
	Ba	F. Dehairs fdehairs@vub.ac.be, D. Cardinal dcardinal@africamuseum.be	D. Cardinal dcardinal@africamuseum.be	fdehairs@vub.ac.be, dcardinal@africamuseum.be
	d30Si	D. Cardinal damien.cardinal@africamuseum.be F. Fripiat ffripiat@africamuseum.be	F. Fripiat ffripiat@africamuseum.be D. Cardinal damien.cardinal@africamuseum.be	damien.cardinal@africamuseum.be ffripiat@africamuseum.be
	d30BSi	D. Cardinal damien.cardinal@africamuseum.be F. Fripiat ffripiat@africamuseum.be	F. Fripiat ffripiat@africamuseum.be D. Cardinal damien.cardinal@africamuseum.be	damien.cardinal@africamuseum.be ffripiat@africamuseum.be
	234Th	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
	226Ra	C. Hanfland, chanfland@awi-bremerhaven.de		chanfland@awi-bremerhaven.de
	Inc 15N & 13C	Pedro Monteiro pmonteir@csir.co.za, Howard Waldron howard.waldron@uct.ac.za	Howard Waldron howard.waldron@uct.ac.za, Sandy Thomalla sandy_thomalla@yahoo.com, Warren Joubert wjoubert@csir.co.za	pmonteir@csir.co.za
REE Super	O2	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr	Sabrina.Speich@univ-brest.fr

	REE	Catherine Jeandel Catherine.jeandel@notos.cst.cnes.fr, M. Roy-Barman Matthieu.Roy-Barman@lsce.cnrs-gif.fr		Catherine.jeandel@notos.cst.cnes.fr
	Pa	Catherine Jeandel Catherine.jeandel@notos.cst.cnes.fr, M. Roy-Barman Matthieu.Roy-Barman@lsce.cnrs-gif.fr		Catherine.jeandel@notos.cst.cnes.fr
	Nd, 230Th	Catherine Jeandel Catherine.jeandel@notos.cst.cnes.fr, François Lacan lacan@legos.obs-mip.fr, M. Roy-Barman Matthieu.Roy-Barman@lsce.cnrs-gif.fr		Catherine.jeandel@notos.cst.cnes.fr
	234Th	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be		fdehairs@vub.ac.be
GEOTRACES dBa intercalibration	see special sheet	Frank Dehairs		fdehairs@vub.ac.be
GEOTRACES d30Si intercalibration	see special sheet	Damien Cardinal	François Fripiat/Damien Cardinal	damien.cardinal@africamuseum.be
GEOTRACES Nd intercalibration	see special sheet	Catherine Jeandel Catherine.jeandel@notos.cst.cnes.fr, François Lacan lacan@legos.obs-mip.fr,		Catherine.jeandel@notos.cst.cnes.fr
GEOTRACES 230Th/231Pa intercalibration	see special sheet	Catherine Jeandel Catherine.jeandel@notos.cst.cnes.fr, M. Roy-Barman Matthieu.Roy-Barman@lsce.cnrs-gif.fr		Catherine.jeandel@notos.cst.cnes.fr
GEOTRACES 230Th/231Pa intercalibration	see special sheet	Catherine Jeandel Catherine.jeandel@notos.cst.cnes.fr, François Lacan lacan@legos.obs-mip.fr,		Catherine.jeandel@notos.cst.cnes.fr
CO2 MD/Polarstern	see special sheet	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	Melchor Gonzales mgonzalez@dqui.ulpgc.es, Magda. Santana jmsantana@dqui.ulpgc.es	mgonzalez@dqui.ulpgc.es
CO2 MD/Polarstern	see special sheet	Bruno Delille, Bruno.Delille@ulg.ac.be	Bruno Delille & Nicolas-Xavier Geilfus, Bruno.Delille@ulg.ac.be & nxgeilfus@ulg.ac.be	Bruno.Delille@ulg.ac.be

Continuous Shipboard Sea Water Sampling (UNDERWAY)

Operation	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
Shipboard continuous water supply	pCO2	Bruno Delille, Bruno.Delille@ulg.ac.be	Bruno Delille & Nicolas-Xavier Geilfus, Bruno.Delille@ulg.ac.be & nxgeilfus@ulg.ac.be	Bruno.Delille@ulg.ac.be
	O2-isot/Ar	Michael Bender bender@Princeton.EDU, Nicolas Cassar ncassar@Princeton.EDU	Pedro Monteiro, pmonteir@csir.co.za	ncassar@Princeton.EDU
	thermosalinometer	IPEV		IPEV

Discrete Shipboard Sea Water Sampling (ship INTAKE water)

Operation	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
Shipboard water supply	Ac-227	W. Geibert	Walter Geibert	W. Geibert
	Ra-226	C. Hanfland, chanfland@awi-bremerhaven.de	C. Hanfland, chanfland@awi-bremerhaven.de	chanfland@awi-bremerhaven.de
	POC	??		
	Alkenones	MA Sicre, marie-alexandrine.sicre@lsce.cnrs-gif.fr	Ullah Ezat, ullah.ezat@lsce.ipsl.fr	marie-alexandrine.sicre@lsce.cnrs-gif.fr
	O2-isot/Ar	Michael Bender bender@Princeton.EDU, Nicolas Cassar ncassar@Princeton.EDU	Pedro Monteiro, pmonteir@csir.co.za	ncassar@Princeton.EDU
	Bacterio	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	brnkir001@uct.ac.za/ kirstb007@gmail.com

Large volume In Situ Pumps

Filter type	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
Petex screen (>50µm)	234Th	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
	210Po	P. Masquè Pere.Masque@uab.es	E. Verdeny Elisabet.Verdeny@uab.cat , N. Escuberta Nuria.casacuberta@uab.cat	Elisabet.Verdeny@uab.cat
	14C POC	Nadine Tisnerat-Laborde, Nadine.Tisnerat@lsce.cnrs-gif.fr	Nadine Tisnerat-Laborde, Nadine.Tisnerat@lsce.cnrs-gif.fr	Nadine.Tisnerat@lsce.cnrs-gif.fr
	Biomarkers	A.-J. Cavagna acavagna@vub.ac.be; F. Dehairs fdehairs@vub.ac.be	A.-J. Cavagna acavagna@vub.ac.be; F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
Quartz filter QMA	234Th	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	F. Planchon frederic.planchon@africamuseum.be; F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
	210Po	P. Masquè Pere.Masque@uab.es	E. Verdeny Elisabet.Verdeny@uab.cat , N. Escuberta Nuria.casacuberta@uab.cat	Elisabet.Verdeny@uab.cat
	14C POC	Nadine Tisnerat-Laborde, Nadine.Tisnerat@lsce.cnrs-gif.fr	Nadine Tisnerat-Laborde, Nadine.Tisnerat@lsce.cnrs-gif.fr	Nadine.Tisnerat@lsce.cnrs-gif.fr
	Biomarkers	A.-J. Cavagna acavagna@vub.ac.be; F. Dehairs fdehairs@vub.ac.be	A.-J. Cavagna acavagna@vub.ac.be; F. Dehairs fdehairs@vub.ac.be	fdehairs@vub.ac.be
	Alkenones	MA Sicre, marie-alexandrine.sicre@lsce.cnrs-gif.fr	Ullah Ezat, ullah.ezat@lsce.ipsl.fr	Marie - Alexandrine Sicre

Supor filter (0.4 µm)	Nd, Pa, Th, REE	Catherine Jeandel Catherine.jeandel@notos.cst.cnes.fr, François Lacan lacan@legos.obs-mip.fr, M. Roy-Barman Matthieu.Roy-Barman@lsce.cnrs-gif.fr		Catherine.jeande
	d30BSi	D. Cardinal damien.cardinal@africamuseum.be F. Fripiat ffripiat@africamuseum.be	F. Fripiat ffripiat@africamuseum.be D. Cardinal damien.cardinal@africamuseum.be	damien.cardinal ffripiat@africamuseum.be
Cartridges	227Ac	W. Geibert	Walter Geibert	W. Geibert
	Ra	C. Hanfland, chanfland@awi-bremerhaven.de		chanfland@awi-bremerhaven.de

GoFLO bottle sampling via Kevlar cable

GoFlo Cast	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
LARGE (0-2000 m)	DMe	Marie Boye, marie.boye@univ-brest.fr	Bronwyn Wake, bronwyn.wake@gmail.com	Bronwyn Wake,
	TMe	Marie Boye, marie.boye@univ-brest.fr	Bronwyn Wake, bronwyn.wake@gmail.com	Bronwyn Wake,
	DCo,DZn, DCd	Marie Boye, marie.boye@univ-brest.fr	Johann Bown, johann.bown@univ-brest.fr	Johann Bown
	DFe	Géraldine Sarthou, Eva Bucciarelli	Fanny Chever	fanny.chever@univ-brest.fr
	TDFe	Géraldine Sarthou, Eva Bucciarelli	Fanny Chever	fanny.chever@univ-brest.fr
	Orga-Co,Orga-Zn, Orga-Cd	Marie Boye, marie.boye@univ-brest.fr	Johann Bown, johann.bown@univ-brest.fr	johann.bown@univ-brest.fr
	Orga-Fe	Stan van den Berg, vandenberg@liv.ac.uk		vandenberg@liverpool.ac.uk
	Orga-Mn/Cu	Marie Boye, marie.boye@univ-brest.fr		marie.boye@univ-brest.fr
	DMn, DCu	Marie Boye, marie.boye@univ-brest.fr		marie.boye@univ-brest.fr
	Sol-Fe	Géraldine Sarthou, Eva Bucciarelli	Fanny Chever	fanny.chever@univ-brest.fr
	TFe(II)	Géraldine Sarthou	Géraldine Sarthou	geraldine.sarthou@univ-brest.fr
	TH2O2	Eva Bucciarelli	Eva Bucciarelli	eva.bucciarelli@univ-brest.fr
	DH2O2	Eva Bucciarelli	Eva Bucciarelli	eva.bucciarelli@univ-brest.fr
	NO3	Marie Boye, marie.boye@univ-brest.fr	Annick Masson, Fred Le Moigne	marie.boye@univ-brest.fr
	S	Pierre Brannelec, pierre.branellec@ifremer.fr	V. Rupolo	pierre.branellec@ifremer.fr
	Microcat	Michel Arhan, Michel.Arhan@ifremer.fr		michel.arhan@ifremer.fr
SUPER-TM's surface (0-1000 m) and	DMe	Marie Boye, marie.boye@univ-brest.fr	Bronwyn Wake, bronwyn.wake@gmail.com	bronwyn.wake@gmail.com
TM's deep (1000-4000 m)	TMe	Marie Boye, marie.boye@univ-brest.fr	Bronwyn Wake, bronwyn.wake@gmail.com	bronwyn.wake@gmail.com

	DCo,DZn, DCd	Marie Boye, marie.boye@univ-brest.fr	Johann Bown, johann.bown@univ-brest.fr	johann.bown@univ-brest.fr
	DFe	Géraldine Sarthou, Eva Bucciarelli	Fanny Chever	fanny.chever@univ-brest.fr
	TDFe	Géraldine Sarthou, Eva Bucciarelli	Fanny Chever	fanny.chever@univ-brest.fr
	Orga-Co,Orga-Zn, Orga-Cd	Marie Boye, marie.boye@univ-brest.fr	Johann Bown, johann.bown@univ-brest.fr	johann.bown@univ-brest.fr
	Orga-Fe	Stan van den Berg, vandenberg@liv.ac.uk		vandenberg@liverpool.ac.uk
	Orga-Mn/Cu	Marie Boye, marie.boye@univ-brest.fr		marie.boye@univ-brest.fr
	DMn, DCu	Marie Boye, marie.boye@univ-brest.fr		marie.boye@univ-brest.fr
	Sol-Fe	Géraldine Sarthou, Eva Bucciarelli	Fanny Chever	fanny.chever@univ-brest.fr
	TFe(II)	Géraldine Sarthou	Géraldine Sarthou	geraldine.sarthou@univ-brest.fr
	TH2O2	Eva Bucciarelli	Eva Bucciarelli	eva.bucciarelli@univ-brest.fr
	DH2O2	Eva Bucciarelli	Eva Bucciarelli	eva.bucciarelli@univ-brest.fr
	DFe isotopes	François Lacan lacan@legos.obs-mip.fr	Amandine Radic radic@legos.obs-mip.fr	radic@legos.obs-mip.fr
	PFe isotopes	François Lacan lacan@legos.obs-mip.fr	Amandine Radic radic@legos.obs-mip.fr	radic@legos.obs-mip.fr
	DAl	M. Boye & Peter Croot, pcroot@ifm-geomar.de		pcroot@ifm-geomar.de
	TAl	M. Boye & Peter Croot, pcroot@ifm-geomar.de		pcroot@ifm-geomar.de
	DCd isotopes	Gideon Henderson, Gideon.Henderson@earth.ox.ac.uk	sonja.ripperger@erdw.ethz.ch	gideon.henderson@earth.ox.ac.uk
	NO3	Marie Boye, marie.boye@univ-brest.fr	Annick Masson, Fred Le Moigne	marie.boye@univ-brest.fr
	S	Pierre Brannelec, pierre.branellec@ifremer.fr	V. Rupolo	pierre.branellec@ifremer.fr
	Microcat (surface casts)	Michel Arhan, Michel.Arhan@ifremer.fr		michel.arhan@ifremer.fr
	Pinger (deep casts)	IPEV		IPEV
SUPER- Cd + incub. Bron	DCd isotopes	Gideon Henderson, Gideon.Henderson@earth.ox.ac.uk	sonja.ripperger@erdw.ethz.ch	gideon.henderson@earth.ox.ac.uk
	incub. Bron	Marie Boye, marie.boye@univ-brest.fr	Bronwyn Wake, bronwyn.wake@gmail.com	bronwyn.wake@gmail.com

	incub. Pedro	Pedro Monteiro	Sandy Thomalla	pmonteir@csir.co.za
	NO3	Marie Boye, marie.boye@univ-brest.fr	Annick Masson, Fred Le Moigne	marie.boye@univ-brest.fr
	S	Pierre Brannelec, pierre.branellec@ifremer.fr	V. Rupolo	pierre.branellec@ifremer.fr
	Microcat	Michel Arhan, Michel.Arhan@ifremer.fr		michel.arhan@ifremer.fr
SUPER-Fe isotopes	DFe isotopes	François Lacan lacan@legos.obs-mip.fr	Amandine Radic radic@legos.obs-mip.fr	radic@legos.obs-mip.fr
	PFe isotopes	François Lacan lacan@legos.obs-mip.fr	Amandine Radic radic@legos.obs-mip.fr	radic@legos.obs-mip.fr
	NO3	Marie Boye, marie.boye@univ-brest.fr	Annick Masson, Fred Le Moigne	marie.boye@univ-brest.fr
	S	Pierre Brannelec, pierre.branellec@ifremer.fr	V. Rupolo	pierre.branellec@ifremer.fr
	Microcat	Michel Arhan, Michel.Arhan@ifremer.fr		michel.arhan@ifremer.fr
SUPER-incub. Bron	incub. Bron	Marie Boye, marie.boye@univ-brest.fr	Bronwyn Wake, bronwyn.wake@gmail.com	bronwyn.wake@gmail.com
	Microcat	Michel Arhan, Michel.Arhan@ifremer.fr		michel.arhan@ifremer.fr
SUPER-incub. Gérald.	incub. Géraldine/Eva	Géraldine Sarthou, Eva Bucciarelli		Eva.Bucciarelli@univ-brest.fr, Geraldine.Sarthou@univ-brest.fr
	Microcat	Michel Arhan, Michel.Arhan@ifremer.fr		michel.arhan@ifremer.fr
GEOTRACES TM's intercalibration	see special sheet	Marie Boye, marie.boye@univ-brest.fr		marie.boye@univ-brest.fr

Oktopus sediment core sampling

Core profiles	Parameter	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
	O2	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	pH	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	TCO2	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	NO2- + NO3-	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	H4SiO4	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	NH4+	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	TPO4	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	SO42-	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	Fe	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	Mn	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	DOC	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	Ba, U, Mo	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	TTM	Marie Boye, marie.boye@univ-brest.fr	B. Wake bronwyn.wake@gmail.com, J. Bown johann.bown@univ-brest.fr	johann.bown@univ-brest.fr, bronwyn.wake@gmail.com
	δSi	D. Cardinal damien.cardinal@africamuseum.be F. Fripiat ffripiat@africamuseum.be	F. Fripiat ffripiat@africamuseum.be D. Cardinal damien.cardinal@africamuseum.be	damien.cardinal@africamuseum.be ffripiat@africamuseum.be
	δFe	F.Lacan lacan@legos.obs-mip.fr	F.Lacan lacan@legos.obs-mip.fr	lacan@legos.obs-mip.fr
	δCd	M. Boye, G. Henderson Gideon.Henderson@earth.ox.ac.uk	sonja.ripperger@erdw.ethz.ch	sonja.ripperger@erdw.ethz.ch
	bulk porosity	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	%detrital	A. Roychoudhury alakendra.roychoudhury@uct.ac.za	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	A. Roychoudhury alakendra.roychoudhury@uct.ac.za
	%CaCO3	A. Roychoudhury alakendra.roychoudhury@uct.ac.za	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	A. Roychoudhury alakendra.roychoudhury@uct.ac.za
	%BSi	A. Roychoudhury alakendra.roychoudhury@uct.ac.za	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	A. Roychoudhury alakendra.roychoudhury@uct.ac.za

	TTM	A. Roychoudhury alakendra.roychoudhury@uct.ac.za	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	A. Roychoudhury alakendra.roychoudhury@uct.ac.za
	granulometry	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	210Pb	P. Masquè Pere.Masque@uab.es	Elisabet Verdeny Elisabet.Verdeny@uab.cat	Elisabet Verdeny Elisabet.Verdeny@uab.cat
	210Po	P. Masquè Pere.Masque@uab.es	Elisabet Verdeny Elisabet.Verdeny@uab.cat	Elisabet Verdeny Elisabet.Verdeny@uab.cat
	230 Th	F.Lacan lacan@legos.obs-mip.fr	F.Lacan lacan@legos.obs-mip.fr	lacan@legos.obs-mip.fr
	δ13C	N. Laborde Nadine.Tisnerat@lsce.cnrs-gif.fr	N. Laborde Nadine.Tisnerat@lsce.cnrs-gif.fr	Nadine.Tisnerat@lsce.cnrs-gif.fr
	δ15N	P. Monteiro pmonteir@csir.co.za	P. Monteiro pmonteir@csir.co.za	viollier@ipgp.jussieu.fr
	14C	N. Laborde Nadine.Tisnerat@lsce.cnrs-gif.fr	N. Laborde Nadine.Tisnerat@lsce.cnrs-gif.fr	Nadine.Tisnerat@lsce.cnrs-gif.fr
	234Th	F.Planchon frederic.planchon@marion.ipev.fr	F.Planchon frederic.planchon@marion.ipev.fr	frederic.planchon@marion.ipev.fr
	Alkenones	M.A Sicre Marie-Alexandrine.Sicre@lsce.cnrs-gif.fr	U.Ezat Ullah.Ezat@lsce.ipsl.fr	Marie-Alexandrine.Sicre@lsce.cnrs-gif.fr
	TAA	A.Grémare a.gremare@epoc.u-bordeaux1.fr	A.Grémare a.gremare@epoc.u-bordeaux1.fr	a.gremare@epoc.u-bordeaux1.fr
	Pigments	A.Grémare a.gremare@epoc.u-bordeaux1.fr	A.Grémare a.gremare@epoc.u-bordeaux1.fr	a.gremare@epoc.u-bordeaux1.fr
	Meïofauna	A.Grémare a.gremare@epoc.u-bordeaux1.fr	A.Grémare a.gremare@epoc.u-bordeaux1.fr	a.gremare@epoc.u-bordeaux1.fr
	Corg	A.Grémare a.gremare@epoc.u-bordeaux1.fr	A.Grémare a.gremare@epoc.u-bordeaux1.fr	a.gremare@epoc.u-bordeaux1.fr
	AVS	A. Roychoudhury alakendra.roychoudhury@uct.ac.za	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	A. Roychoudhury alakendra.roychoudhury@uct.ac.za
	CRS	A. Roychoudhury alakendra.roychoudhury@uct.ac.za	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	A. Roychoudhury alakendra.roychoudhury@uct.ac.za
	S(0)	A. Roychoudhury alakendra.roychoudhury@uct.ac.za	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	A. Roychoudhury alakendra.roychoudhury@uct.ac.za
	SRR	A. Roychoudhury alakendra.roychoudhury@uct.ac.za	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	A. Roychoudhury alakendra.roychoudhury@uct.ac.za
	NC	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	brnkir001@uct.ac.za/ kirstb007@gmail.com
	MB	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	K. Barnes brnkir001@uct.ac.za/ kirstb007@gmail.com	brnkir001@uct.ac.za/ kirstb007@gmail.com

Whole core incubations				
	FO2	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	FNO3	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	FNH4+	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	FH4SiO4	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	FPO4	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	FBa, FMo, FU	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr
	FTTM	Marie Boye, marie.boye@univ-brest.fr	B. Wake bronwyn.wake@gmail.com, J. Bown johann.bown@univ-brest.fr	johann.bown@univ-brest.fr, bronwyn.wake@gmail.com
	FDOC	E.Viollier viollier@ipgp.jussieu.fr	E.Viollier viollier@ipgp.jussieu.fr	viollier@ipgp.jussieu.fr

CTD sensors

Rosette Cast	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
	Temperature1	Sabrina.Speich@univ-brest.fr	Sabrina.Speich	
	Temperature2	Sabrina.Speich@univ-brest.fr	Sabrina.Speich	
	Conductivity1	Sabrina.Speich@univ-brest.fr	Sabrina.Speich	
	Conductivity2	Sabrina.Speich@univ-brest.fr	Sabrina.Speich	
	O2	Sabrina.Speich@univ-brest.fr	Sabrina.Speich	
	LADCP (up and down; 300 kHz each)	Sabrina.Speich@univ-brest.fr	Sabrina.Speich	
	Fluo	Herve.Claustre@obs-vlfr.fr	Herve.Claustre	
	Transmissiometer			
	PAR			
	Pinger			

Satellite data (remote sensing)

Data ressource	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
ODYSSEA	SST (sea surface temp.)	Sabrina Speich		
MODIS	SST (sea surf. Temp.)	Sabrina.Speich		
AVISO	Altimetry	Sabrina Speich		
SeaWIFs	Ocean data color	Bertrand Saulqui, bsaulqui@ifremer.fr		
SeaWIFs	"white signals"	Marie Boye		
NAUSICAA	wind direction & speed	Christophe Messager		
NAUSICAA	atm. particulate density	Christophe Messager		
NAUSICAA	irradiance	Christophe Messager		

Atmospheric sensors

Operation	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base

See E. Key (Erica.Key@cetp.ipsl.fr, ericalkey@gmail.com)
and C. Messager (Christophe.Messager@ifremer.fr) report in the cruise report

Aerosols/dust and rain

Operation	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
aerosols collector	dust	Alexander Baker, Alex.Baker@uea.ac.uk	Alexander Baker, Alex.Baker@uea.ac.uk	Alex.Baker@uea.ac.uk
rain collector	rain	Alexander Baker, Alex.Baker@uea.ac.uk	Alexander Baker, Alex.Baker@uea.ac.uk	Alex.Baker@uea.ac.uk

Physics captors deployements

Operation	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
XBTs	Temperature, Depth		Sebastian Swaart	sebastiaan.swart@uct.ac.za
PROVOR	Temperature, Salinity, Depth		Sabrina Speich	speich@univ-brest.fr
CPIES	Current Speed, Acoustical Time, Bottom Pressure		Sabrina Speich	speich@univ-brest.fr
SADCP	Current Speed in the upper layers along the cruise track		Sabrina Speich	speich@univ-brest.fr

Ship captors and data

Operation	Parameter sampled	Scientific responsible(s) & Email(s)	Analyses responsible(s) & Email(s)	Email contact(s) for the data-base
SADCP (150 kHz)		Sabrina.Speich@univ-brest.fr		
SADCP (75 kHz)				
Thermosalinometer		Sabrina.Speich@univ-brest.fr		
Navigation		Sabrina.Speich@univ-brest.fr		
Meteo		Christophe.Messager@ifremer.fr		

CONCLUSION

Keeping the logbook up-to-date required a regular exchange with the scientists, a permanent monitoring of the operations on the deck and during the water sampling, and a contribution to the cruise organization, in order to have an overview of the daily operations.
As a database coordinator, this work consists in ensuring a correct transfer and daily distribution of information between scientists (distribution of the “bridge” and the participating “rosette” logs, for instance).

This logbook is the initial step to provide the essential references which are needed to identify of the different tasks and samples. The whole scientific community can thus have a global view of all of the activities undertaken during the cruise.
All the referencements will be added to the shared database in the LEFE-CYBER program, under the responsability of Marie-Paule Torre:
http://www.obs-vlfr.fr/proof/bonusgh

VERSION FRANÇAISE

BONUS GOOD HOPE 2008: "LOGBOOK"

par Elodie Kestenare (responsable du Logbook à bord)
Marie-Paule Torre (responsable base de données)

Le logbook s'inscrit dans le processus “gestion” de base de données LEFE-CYBER d'une campagne océanographique. Sa conception est née du travail du comité “BD BGH”.

Le présent rapport décrit succintement le logbook crée pendant la mission.
Les objectifs sont de répertorier toutes les opérations à bord, de recenser tous les prélèvements effectués et les paramètres mesurés (analysés à bord ou à posteriori) pour établir des réferencements uniques.

Cette collecte d'informations s'articule autour de trois démarches:
- déroulement de toutes les opérations à bord,
- recensement de tous les prélevements sur chaque instrument,
- caractérisation et inventaire de tous les paramètres physique et biogéochimique (océan et atmosphère) pour mettre à jour et compléter le dictionnaire de données.

Ce travail est réalisé aux moyens de fiches listant les déploiements, les prélèvements, les mesures, etc... en interaction directe avec l'ensemble des scientifiques embarqués. Ces fiches sont ensuite systématiquement informatisées pour constituer le logbook, étape préliminaire incontournable à la mise en place de la base de données.

(1) DÉROULEMENT DE TOUTES LES OPÉRATIONS À BORD: LE “JOURNAL PASSERELLE”

Il répertorie toutes les opérations effectuées quotidiennement à bord, tant sur les déploiements/mises à bord des instruments (bathysonde CTD, GOFLO, pompes in-situ, oktopus) et largages (flotteurs PROVOR, XBT, C-PIES, ballons radio sondes)

1-A. OPERATIONS “OCEAN”

Se réferer à la partie anglaise.

1-B OPERATIONS “ATMOSPHERE” - RADIO SONDES

Se reporter au chapitre “Atmosphère” du rapport de mission .

(2) RECENSEMENT DE TOUS LES PRÉLEVEMENTS SUR CHAQUE INSTRUMENT

Il s'agit de relever avec précision tous les types de paramètres prélevés (physique et biogéochimie, océanographique et atmosphérique), les profondeurs de prélevements, et les volumes d'eau en fonction des instruments à chaque station.

Certains de ces documents sont en annexe du présent rapport et tous seront prochainement disponibles sur le site internet de la base de données de BGH (CYBER) en accès restreint dans la rubrique “basic files”.

Rosette CTD (en annexe 1) :

- Journal Rosette: cf. bgh000-110_rosette_btl.xls
- Journal Bouteille (profondeurs de claquage de bouteilles):
  cf. bgh000-110_depths_btl.xls
- Feuilles de prélevements pour les 79 stations géographiques (111 CTD)
  cf. Prelevement_*typecast*_CTD*numéropalanquée*.xls

En annexe de ce rapport vous disposerez des journaux Pompes In Situ et GoFlo :

- Annexe 2 : journal des PIS
- Annexe 3 : journal des GoFlo

Pour les autres instruments et paramètres prélèves, se réferer aux rapports individuels de chaque responsable scientifique.

(3) DICTIONNAIRE DE DONNÉES

Il s'agit de créer un «dictionnaire BGH» de l'ensemble des paramètres acquis pendant la campagne, tant pour les différents types d'instruments et de paramètres que pour les mesures acquises en continu .

Se reporter à la partie anglaise.

CONCLUSION

La réalisation du logbook nécessite un contact quasi régulier avec les chercheurs, une vigilance permanente sur le pont et lors des prélèvements, de contribuer à l'organisation, d'avoir une vue d'ensemble de toutes les opérations au quotidien.

De plus, en tant que centralisateur de données, ce travail consiste à assurer le relais et la diffusion des informations collectées (journal passerelle, journal rosette, etc...).

Ainsi, le logbook fournit les réferences indispensables à l'identification des travaux et des prélèvements. L'ensemble de la communauté scientifique pourra ainsi accéder à une vision globale des activités réalisées pendant la campagne.

Ce réferencement va alimenter la base de données commune mise en place dans le cadre LEFE-CYBER sous la responsabilité de Marie-Paule Torre:
http://www.obs-vlfr.fr/proof/bonusgh

Implemented equipments

1. The vessel

Name: Marion Dufresne
Owner: GIE MD2
C/o CMA-CGM
4, Quai d'Arenc
FR-13002 Marseille
Operator: CMA-CGM
4, Quai d'Arenc
FR-13002 Marseille
Cruise charter: IPEV
Technopôle Brest Iroise
BP 75
FR-29280 Plouzané
Port of registry: Marseille (France)
Registration number: RI829498 D
IMO number: 9050814

Caracteristics

Length overall: 120.50 m
Moulded breadth: 20.61 m
Water pull off: 6.95 m
Main engines: 2 x 3000 kW
Prospeller shafts: 2
Steering gear: 2 safrans Beker, 2 flap rudders
Box thrusters: 1 x 750 kW
Generators: 2 x 2880 kW, 1 x 2100 kW
Maximum speed: 16 knots

Personnel capacity

Maximum passengers: 110 persons
Number of crew: 10 officers, 20 crew, 20 embarked stevedores
Maximum capacity: 160 persons

2. Radiocommunication and radiosailing

	Nb	Equipment	Type and Model	Frequency	Emitting power
Satellite comm.	1	Inmarsat-B	NERA Satrun B	1.6 GHz	33 dBW
	1	Inmarsat Fleet 77	NERA F77	1.6 GHz	
	1	Inmarsat-C	SKANTI ScanSat-CG	1.6 GHz	140 W

	Nb	Equipment	Type and Model	Frequency	Emitting power
Distress search, rescue	1	EPIRB Sarsat-Cospas	KANNAD 406WH	406 MHz, 121.5 MHz	5 W
	2	SART	SERPE Rescuer	9 GHz	0.5 W
	1	Automatic Identification System	SKANTI AIS2100	162 MHz	12 W

	Nb	Equipment	Type and Model	Frequency	Emitting power
HF and VHF comm.	1	Primary marine USB transceiver	SKANTI TRP8400	1.6-4 MHz	400 W
				4-27.5 MHz	400 W
	1	Secondary marine USB transceiver	SKANTI TRP8750	1.6-4 MHz	750 W
				4-27.5 MHz	750 W
	2	Marine VHF transceiver	SKANTI VHF3000	156-162 MHz	25 W

	Nb	Equipment	Type and Model	Frequency	Emitting power
Bridge	1	X-band radar	DECCA C.342/6	9380-9440 MHz	25 kW
	1	S-band radar	DECCA C.343-S90	3040-3060 MHz	30 kW
	1	High-depth Echo Sounder	JRC JFE-570SD	50 kHz	2 kW
	1	Small-depth Echo Sounder	JRC JFE-570S	200 kHz	2 kW

3. Scientific equipments

a. Sounders and captors

Parameter	Method	Equipment	Owner
Sailing	Triangulation GPS or DGPS	GPS or DGPS receivers	Marion-Dufresne
Sediments sounder	Multi-beam	reflectance and 3.5 kHz echosounder	IPEV
Bathymetry-altimetry	Acoustic sensor	PINGER	LPO
Bathymetry-altimetry	Acoustic sensor	PINGER	IPEV
Under-water inverted altimetry		MICROCAT	LPO
Underway surface currents	ADCP	38 kHz shell ADCP	IPEV
Full-depth currents	LADCP	2 WH RDI 300 kHz LADCP	LPO
Underway surface temperature and salinity	Thermosalinometer	SBE21	IPEV
Full-depth temperature, salinity, pressure, oxygen	CTD (conductivity-temperature-depth)	2 CTD SEA-BIRD SBE911 sounders	LPO
Fluorimetry	Fluorimeter	Chelsea	INSU
Water transmissiometry	Transmissiometer	C-Star	INSU
Light water attenuation	Optic sensors	S-PAR (ref.) and PAR	INSU
Thermales probes	Thermicity	Expandable bathythermographs (XBT)	UCT (SA)
High-frequency full-depth temperature, salinity, bottom pressure and current	Bottom moorings	2 currentmeters inverted echo-sounders (C-PIES)	LPO
Atmospheric physics and meteorology	Balloons with sensors (full hight troposphere), deck-sensors	Captors and radiosounding	LEFE (LEMAR/LPO), Meteo France, RSMAS

b. Samplers

Parameter	Method	Equipment	Owner
Water sampling	Deep casts	SBE 32 Frame (24 bottles)	INSU
Water sampling	Niskin bottles	24 x 12L Niskin bottles equipped with Teflon springs	INSU
Ultra-clean water sampling	Deep casts	Kevlar line, 11 Teflon messengers, epoxy coated weight	NIOZ (NL)
Ultra-clean water sampling	GO-FLO bottles	10 x 12L GO-FLO bottles	LEMAR
Large volume water sampling (for particles)	In situ pumps	3 MACLANE WTS6-1-142 L	INSU
Large volume water sampling (for particles)	In situ pumps	4 monopost CHALLENGER OCEANICS (diam. 293 mm)	INSU
Large volume water sampling (for particles)	In situ pumps	3 bi-post CHALLENGER OCEANICS (diam. 142 mm)	INSU
Large volume water sampling (for particles)	In situ pumps	1 « Simpson » CHALLENGER OCEANICS (diam. 292 mm)	ULB (Belgium)
Large volume water sampling (for particles)	In situ pumps	1 bi-post CHALLENGER OCEANICS (diam. 292 mm)	UAB (Spain)
Sediment and pore waters sampling	Surficial multi-coring	Oktopus corer (8 multi-tubes)	INSU
Aerosols and rain sampling	Air filtration and rain collection	Aerosols: high-volume (1 m^3 min^{-1}) sampler equipped with a bulk aerosol sampling head with filter. Rain: large (40 cm diam.) plastic funnels.	UEA (UK)
Atmospheric CO2 sampling	Air pumping	NDIR	UdL (Belgium), ULPGC (Spain)
Surface seawater sampling	Seawater pumping	Online ship- intake water pumping	IPEV

c. Containers

Parameter	Equipment	Owner
Oxygen, salinity analyses	20 feets chemical laboratory container	LPO
Ultra-clean sampling and analyses	20 feets chemical laboratory container	INSU
Ultra-clean and stable isotopes sampling and analyses	20 feets chemical laboratory container	IUEM
Trace elements and stable isotopes sampling and analyses	20 feets chemical laboratory container	VUB (Belgium)
Transport of INSU and laboratories equipments	2 x 20 feets containers	INSU
Transport of C-PIES, profiling floats and hydrological equipments	2 x 20 feets containers	LPO
Storage of frozen samples	20 feets frozen containers (-20°C)	Rent by IPEV

Public outreach

1. Carnet de bord

A four days to weekly diary of the cruise was made by a student in scientific journalism, Vincent Pasquéro, and posted on the IPEV web site of Bonus-Goodhope (http://www.ipev.fr/pages/bonus/AccueilBonusGoodhope.html) by Jean-Paul Humblot (Assistant en Communication, IPEV). The progress of the cruise and the scientific operations were reported in this blog.

2. Web site of Bonus-Goodhope

The Bonus-Goodhope project and latest news are available in the IUEM web-link http://univ-brest.fr/IUEM/BONUS-GOODHOPE/ (webmaster Alain Le Mercier, LEMAR).

3. Education

A public space to adress educative issues in relation with the Bonus-Goodhope project was prepared by M. Boye and is available on the IPEV web page of Bonus-Goodhope (http://www.ipev.fr/pages/bonus/AccueilBonusGoodhope.html).

The project serves also for educative project for French primary scholars (classe de CE2 de C. Moissard, Ecole de Malakoff, FR-92240, in contact with M. Boye and V. Pasquéro), and secondary scholars (Classe de Cleusmeur à Lesneven, FR-29, in collaboration with the « Club CNRS Jeunes » enliven by l'Association des Petits Débrouillards en Bretagne and M. Boye).

4. Exhibition

During the cruise Vincent Pasquéro documented the cruise with scientific interviews, short-cut movies of the scientific operations and pictures. This collected material will help to document an intinerary exhibition of the Bonus-Goodhope project and the 4th International Polar Year that will be inaugured during Brest-2008 (July, 10-17, 2008; Brest, France). Alain Lesquer (IPEV) is in charge of editing the exhibition.

Acknowledgments

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IPEV was in charge of the logistic for the French participation of the cruise and for the operations at sea.

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