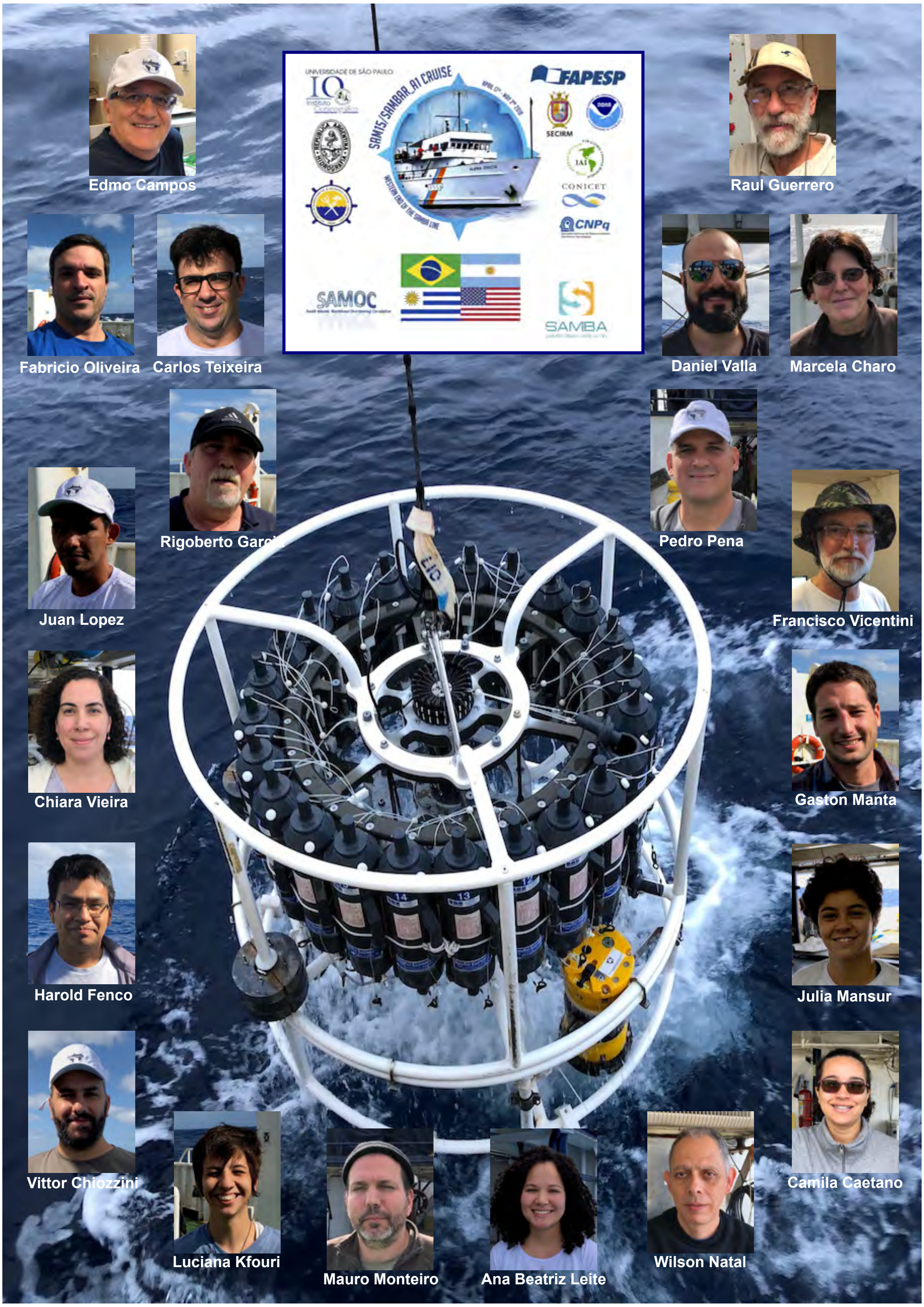
Cruise Report

SAMBAR_A1 - *NOc. Alpha-Crucis*

April 20th – May 3rd / 2018

Interannual Variability of the Meridional Transports across the SAMOC Basin-wide Array (SAMBAR)

(FAPESP – Grant 2017/09659-6)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Vittor Chiozzini
Camila Caetano
Luciana Kfouri
Mauro Monteiro
Ana Beatriz Leite
Wilson Natal

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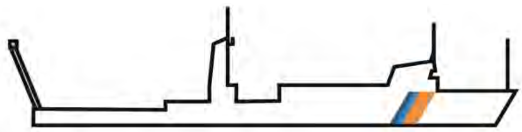


NOc Alpha-Crucis

Technical Summary

Research Vessel: *NOc Alpha-Crucis*
Ship's Captain: Helvécio de M. Rezende

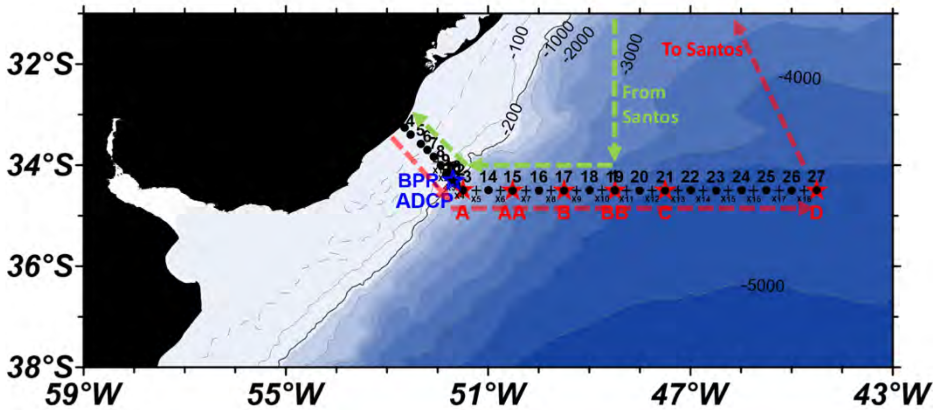
Departing date: April/20/2018 - Return to Port: May/03/2018

Project: Interannual Variability of the Meridional Transports across the SAMOC Basin-wide Array (SAMBAR) – FAPESP Grant No. 2018/09659-6

Project's Principal Investigator: Prof. Dr. Edmo J. D. Campos

Main Research Objective: To service moored instruments and collect physical and biogeochemical data to study the variability of the South Atlantic Meridional Overturning Circulation (SAMOC) and the impacts on climate from regional to global scales.

Study Area: SAMOC Basin-wide Array (SAMBA) – along latitude 34.5º S, from the coast to 44.5ºW.



Participants: 20 Scientist, from Argentina, Brazil, the United States and Uruguay, and 19 crew members.

SAM15/SAMBAR_A1 Cruise - April 20 – May 3 / 2018

Ship's Captain: José Helvécio M. de Rezende
Chief Scientist: Edmo J. D. Campos

Scientific Summary

The South Atlantic Meridional Overturning Circulation (**SAMOC**) is a scientific program started in 2007 as an international cooperation among institutions from Brazil, Argentina, South Africa, the USA, France, the UK, Germany and other European countries. SAMOC is endorsed by **CLIVAR**. Its field activities started in 2009 in the context of Project **SAM**, led by the U.S. National Oceanic and Atmospheric Administration (NOAA), in cooperation with institutions in Argentina and Brazil. The Brazilian contribution, a component of the GOOS-Brazil Program, has been funded since 2011 by the São Paulo State funding foundation (FAPESP) through Projects SAMOC-BR (grant 2011/50552-4) and **SAMBAR (grant 2017/09659-6)**. For more information on SAMOC refer to: http://www.aoml.noaa.gov/phod/SAMOC_international.

Project SAMBAR is a new contribution to SAMOC aiming at a better understanding of the interannual variability of the heat content and meridional transports across the SAMOC Basin-wide Array (SAMBA) and the impacts on the South Atlantic Circulation, on the Regional Climate and on the MOC stability. SAMBAR will maintain and enhance the existing observing array with the deployment of new instruments and the conduction of oceanographic cruises. This document describes the activities carried out onboard the University of São Paulo's oceanographic vessel *NOc Alpha-Crucis*, as the 15th cruise of the SAM Project and the **first of SAMBAR type A** cruises.

The oceanographic campaign in the South Atlantic Ocean covered a transect extending along the latitude 34.5° S from near the South American coast to the longitude 44° 30' W, a section usually referred as the western end of the SAMOC Basin-wide Array (SAMBA). During the cruise, from April 20th to May 3rd, 27 full-depth, GO-Ship quality CTD stations were occupied, with the sampling of physical and biogeochemical properties in the entire water column. It was also conducted the telemetry of data from inverted eco-sounders and the recovery, reconditioning and redeployment of instruments moored on the sea-flor. Additionally, the total of 46 expendable bathy-thermograph (XBT) probes were launched, 18 along the 34.5° S transect and 28 on the return track, from 34.5° S, 44.5° W to 23.97° S, 46.30° W .

Twenty scientists participated in the cruise: 8 from IOUSP; 2 from the Federal University of Rio Grande (FURG); 2 from Servício de Hidrografia Naval (SHN) de la Armada Argentina; 2 from the Instituto de Investigación y Desarrollo Pesquero (INIDEP), de Argentina; 2 from NOAA; and 1 from each of Universidade Federal do Ceará (UFC); Universidade Estadual do Rio de Janeiro (UERJ); Universidade Federal da Bahia (UFBA) and from the Universidad de la República del Uruguay (UdelaR).

1. Scientific Background

The South Atlantic Ocean connects three major basins: the Pacific, the North Atlantic and the Indian Oceans. The mean meridional circulation of the South Atlantic Ocean involves a deep, southward flow of cold and salty North Atlantic Deep Water along the eastern coast of South America, and a compensating northward flow of a mixture of warm and salty surface waters, and cooler and fresher Antarctic Intermediate Waters in the interior. Differently from other subtropical basins, this circulation pattern, in which warm waters flow towards the equator and cold water towards the pole, results in an equatorward heat flux. Although this anomalous heat flux was recognized by the middle of the 20th century, its variability and the sources for the upper return flow that makes it possible are still not well understood.

Observations indicate that a portion of the South Atlantic upper waters are produced locally but most of the upper waters are thought to originate in the Pacific and Indian oceans. Although the relative contributions of the Pacific and Indian ocean to the South Atlantic upper ocean budget is still controversial, observations indicate that the main gateway for the entrainment of these waters into the subtropical gyre are the boundary regions located at the opposite margins of the basin, i.e., the Brazil/Malvinas Confluence (BMC) and the Agulhas Retroflection Region (ARR). In particular, the western sector of the subtropical South Atlantic presents a complex superposition of different water masses and circulation patterns (Fig. 1) that play a crucial role in the meridional fluxes of heat, salt and other physical and biogeochemical properties[1].

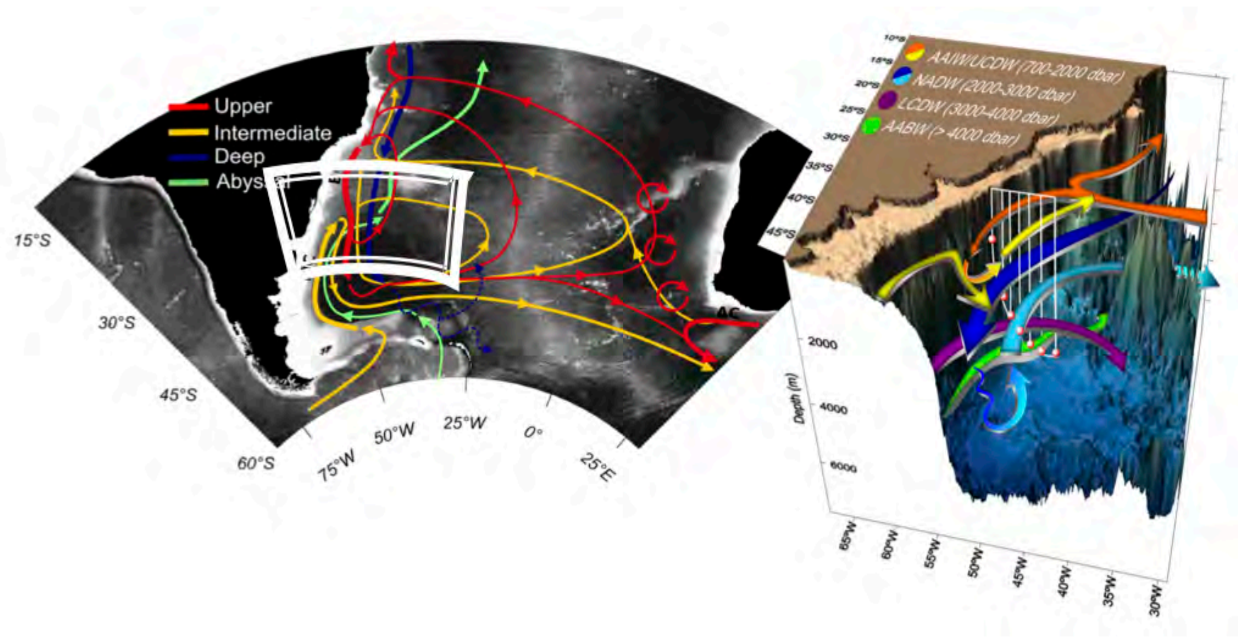


Fig. 1: The region of confluence of the Brazil and Malvinas Currents presents a complex system of different water masses and circulation patterns. The better understanding of this region is an objective of SAM and SAMBAR (figure is a courtesy of D. Valla).

[1] For more about the South Atlantic refer to the Report on the CLIVAR/OOPC/IAI South Atlantic Climate Observing System (SACOS), available at: http://www.clivar.org/node/355

SAMOC (South Atlantic Meridional Overturning Circulation) is an international program to investigate the meridional transports related with the global thermohaline conveyor belt in the South Atlantic. The western end of the SAMOC Basin-wide Array (SAMBA), along 34.5ºS, started in March 2009, with the deployment of four PIES (Pressure enabled Inverted Eco-Sounders). In December 2012, during the joint SAM08 and the first cruise of the SAMOC-BR Project (FAPESP grant 2011/50552-4), three new PIES equipped with currentmeter (C-PIES) were deployed. In the following years, two other instruments were also installed by the project SAMOC-BR: a bottom-mounted ADCP (Acoustic Doppler Current Profiler) and a pressure gauge, also mounted on the sea floor. At present, the instruments on the western end of SAMBA are shown in Fig. 2, together with the location of new instruments to be deployed as part of SAMBAR (sites **0A**, **E** and **F**). An evaluation of present status of the array was determinant in the preparation of the cruise.

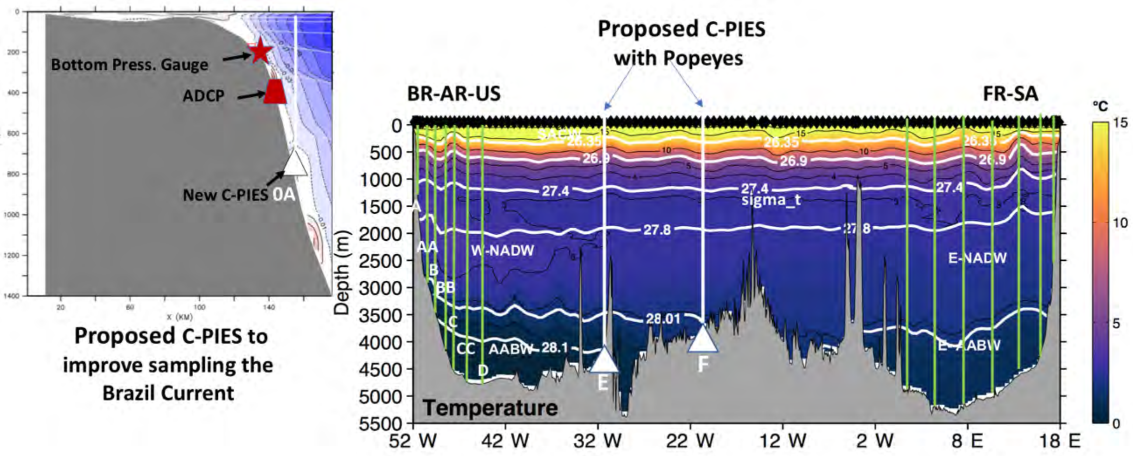


Figure 2: Vertical temperature section along SAMBA (Data from the SAM8/SAMOC-BR1 cruise and the SAMBA/Go-SHIP Cruise on board the *RF Maria Merian*, in January 2017). The location of the bottom mounted SAMBA-west instruments are indicated: a bottom pressure gauge and an ADCP (Brazil) on the shelf-break; the PIES **A,B,C** and **D** (USA) and the C-PIES (Brazil) **AA**, **BB** and **CC**. It is also shown the location of new C-PIES to be moored as part of SAMBAR (**OA**, **E** and **F**).

2. Cruise Preparation

The expedition was designed to collect new data and to service the moored instruments, some of which, such as PIES **A**, **B** and **D** and C-PIES **AA** and **BB**, were in place longer than four years or showed sign of possible malfunction during the telemetry carried out in September 2017 cruise onboard the Argentine vessel *Ara Puerto Deseado*. Just in case replacement were necessary, three new instruments were shipped from the U.S. by NOAA, together with several other components: Upgrade kits for the Brazilian C-PIES; lithium batteries; spare sensors; standard IAPSO water; and several small parts and electronic components. This material was provided as donation by the NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) to the University of São Paulo (see Annex I). Because the Oceanographic Institute does not have an expert in importation, the process was dealt by the Astronomical, Geophysical and Atmospheric Science Institute (IAG). The costs of international freight, airport storage, local

transportation and custom taxes were paid by USP with funds from SAMBAR. Here it is important to highlight that, face to the strike sort of "Standard Operation" carried out by the "Receita Federal" agents, the equipment stayed longer than two weeks in storage at the Airport of Guarulhos – the material arrived in Brazil in March 27th but was delivered at USP only in the afternoon of April 18th, two days prior to the ship's departure. This delay resulted in considerable increase in the cost of storage charged by Infraero.
NOAA's AOML also contributed with the donation with 48 XBT T-5 probes, with profiling capacity of 1800m. Due to shortage of time, an arrangement was made with the Brazilian Navy, which allocated probes previously sent by NOAA as part of an agreement between NOAA and the Directorate of Hydrography and Navigation (DHN), in the context of Project MOVAR.

2.1 – Actions prior to the Ship's Departure

During the weeks prior to the cruise's starting date, a series of urgent and mandatory services and the acquisition of consumables, food supplies, and permanent materials for the *NOc Alpha-Crucis* were required, in order to have the ship capable and ready to navigate. This included maintenance of the air-conditioning system, radio communication and other mechanical, electronic and electrical systems. All the needed services, equipment and consumables, listed in Table I, were paid directly with funds from SAMBAR's budget tagged as "ship-days cost" (Third Part Services), "Consumables" or "Technical Reserve". **As indicated in the project's proposal, the fuel was entirely provided by the Secretariat for the Inter-ministerial Commission for Sea Resources (SeCIRM), in the total of 120.000 liters of diesel oil, with a nominal price of R$3.1423 per liter** (Annex II).

On April 19th, everything was ready, with all the equipment and scientific personnel onboard. The ship departed from the Port of Santos, as scheduled, on April 20th, at 2:00pm (GMT-3)[2].

2.2 – A major problem detected still on land

A crucial item that must receive special attention in the preparation of an oceanographic expedition is the availability of a reliable and efficient mean of communication with land. This is even truer for longer cruises, to remote parts of the ocean, at latitudes prone to frequent and highly energetic storms. A few weeks before the start of the campaign, the project's PI was informed that the ship had no effective contract for internet connection, which is nowadays the most common option for communication. The short-term solution found was the acquisition of pre-paid credits for the use of satellite communication. As listed in Table I, a "recharge" of 200 units of credit was then contracted at the total cost of R$ 8.560,00. According to the information available at that time, this amount of credit would be enough for very limited communication during the foreseen 17 days of the cruise. As described in a later section of this report, this came out to be not accurate. Eventually, extra credits had to be purchased at the additional cost of R$6.420,00 (Table I). Notwithstanding, it is important and fair to register that the IOUSP's Direction

[2] Here and throughout the document, the time is GMT minus 3.

informed the project's Coordinator that a definitive, more intelligent, convenient and cheaper solution is being sought.

Table I: Discrimination of the expenses related to the cruise. The nominal value of the fuel is included to show the effective total cost. FAPESP granted the value of R$ 8,000.00 per "ship day". The amount of R$136,000.00 from these funds were used to pay part of the cruise's overall expenses. The difference was covered with funds from other items of the project's budget: "Technical Reserve", "Third Person Services" and "Consumables".

Total cost of the Cruise		
Description	**Budget item**	**R$**
Air and bus tickets for Brazilian participants from other states	Tech. Reserve	2,917.95
Perdiem for Braz. participants from other states / exterior	Tech. Reserve	4,900.00
Material propaganda (T-Shirts, mugs, caps)	Tech. Reserve	5,650.00
Consumables and services for LIO (Lab. Instrumentação Oceanogr.)	Consumables	7,566.27
Note-books for field work (LIO)	Tech. Reserve	5,400.00
Expenses with customs, transport & Storage material from NOAA	Tech. Reserve	35,852.54
Personnel transport from USP and Santos (round trip)	3rd P. Services	1,600.00
Transport of equipment from USP and Santos (round trip)	3rd P. Services	2,800.00
Satellite communication for internet use during the cruise (OnixSat)	3rd P. Services	8,560.00
Satellite communication (extra credits). OnixSat	3rd P. Services	6,420.00
Lubricant oil (SAKAMOTO)	Tech. Reserve	9,476.00
Food Supplies	3rd P. Services	31,697.20
Installation of ship's Ar Conditioning system (DAICON)	3rd P. Services	31,242.00
Service for reconditioning of an AC part	3rd P. Services	12,103.86
Mechanic services for Alpha Crucis	3rd P. Services	31,476.00
Inspection of fire alarm system (Sinalert)	3rd P. Services	3,950.00
Restauration of Compressors (DRC)	3rd P. Services	2,880.00
Electric material (Eletricenter)	3rd P. Services	7,878.42
Inspection of Radio Station (Radio Holland)	3rd P. Services	4,329.90
Maintenance of Radio SB - Radiomar	3rd P. Services	1,578.95
Maintenance of Radio system parts - Radiomar	3rd P. Services	5,195.80
Payment of mooring specialist services during the cruise	3rd P. Services	8,000.00
Total paid with funds granted by FAPESP		**231,474.89**
120,000 liters of diesel oil provided by SeCIRM – R$ 3.1423/liter		**377,076.00**
Total Cost (including fuel)		**608,550.89**

3. The Cruise Plan, the Effective Track and Participants

According to the project's proposal approved by FAPESP, this **1st cruise of "Type A"** (SAMBAR_A1) was designed to carry out, on the waypoints indicated in Fig. 3, the following activities:

- To retrieve, recondition and relaunch some of the already in place PIES/C-PIES, one acoustic Doppler current profiler (ADCP) and a bottom mounted pressure recorder (BPR);

- To perform acoustic telemetry to retrieve data from some of the PIES/C-PIES
- To carry out a GO-Ship-quality hydrographic section with a rosette equipped with twenty-four 5-liters Niskin bottles and a CTD with double sensors for Conductivity, Temperature, Pressure and Oxygen, one sensor for Fluorescence, and the launching of XBT probes in between the CTD stations.
- To conduct a vertical section of velocity with a lowered ADCP mounted on the rosette;
- To sample and analyze biogeochemical properties of the water column, such as Oxygen concentration, dissolved CO_2, PH, alkalinity and nutrients, using the information and material collected by the sensors and the Niskin bottles;
- To collect continuously, with instruments mounted in the ship, the near surface velocity, air and sea-surface temperature, wind speed and direction, and the concentration of O_2 in the atmospheric boundary layer.

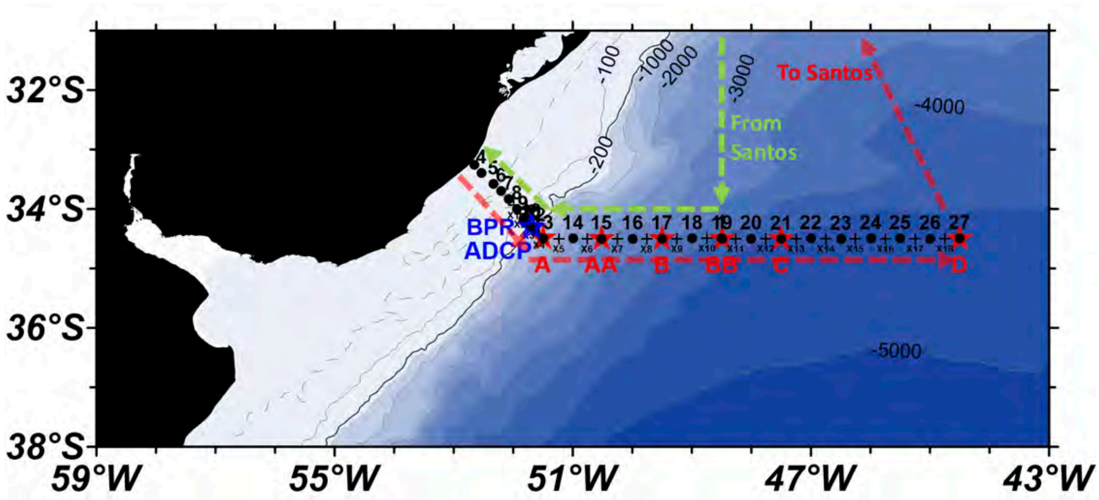


Fig. 3: Map of the stations realized during the cruise, indicating the actual tracks followed by the ship. 18 XBT probes were launched at points in between pairs of adjacent CTD stations.

3.1 Cruise track

Because it would be either necessary or easier and safer to carry out some of the activities at daylight, a decision was made to first go to the Site BB (Fig. 3), location of one of the C-PIES (SN290) that failed to respond the acoustic signals for telemetry during the previous cruise[3]. It was also agreed to carry out a test-CTD station at site BB, to check and tune-up the equipment. From there, the ship sailed westbound, toward the sites of the ADCP and the BPR. At the second waypoint, a station with the Rosette-CTD-LADCP was realized, to collect data intended to compare with the information registered by the sensors in the bottom-mounted ADCP. In this CTD cast, only two Niskin bottles were closed near the bottom, just to collect water for the salinity analysis to calibrate the CTD measurement. After the successful retrieval of both instruments (ADCP and BPR), the

[3] SAM14 - September 2017 - *ARA Puerto Deseado*

ship continued to west until reaching the westernmost station, near the Albardão lighthouse (border Brazil/Uruguay). From there, the actual hydrographic section started to be performed, with the ship steaming back eastbound.

3.2 Participants

There were 20 scientists onboard, from Brazil, Argentina, Uruguay and the United States of America, as listed in Table II. All of the participants were either project's Associate Researchers or students and/or technicians representing them. The air-travel expenses for the participants from other countries were covered by their respective institutions. Funds from SAMBAR were used to cover air- or bus-travel of participants from other states in Brazil and to pay for local transportation, meals and eventual accommodation when not onboard, for all participants from outside São Paulo.

Table II – Participants in the SAMBAR_A1 Cruise

No.	Name	Institution/Country	Activity on board
1	Edmo J. D. Campos	IOUSP/BR	Chief Scientist
2	Francisco L. Vicentini Netto	IOUSP/BR	C-PIES/ADCP/BPR
3	Mauro Quandt Monteiro	IOUSP/BR	C-PIES/ADCP/BPR/Autosal
4	Wilson Natal	IOUSP/BR	C-PIES/ADCP/BPR
5	Chiara Vieira	IOUSP/BR	Chemistry/Nutrients/O2
6	Vittor Chiozzini	IOUSP/BR	Chemistry/Nutrients/O2
7	Ana Beatriz Leite (*)	IOUSP/BR	Chemistry/Nutrients/O2
8	Luciana Ortiz Kfouri (**)	IOUSP/BR	CTD/Autosal/XBT
9	Carlos Peres Teixeira	LABOMAR-UFC/BR	CTD/Biology/Autosal
10	Juan M. Barbosa Lopez (*)	UFBA/BR	CTD/Chemistry/CO2
11	Fabricio S. C. de Oliveira	FURG/BR	CTD/LADCP/Autosal
12	Julia Kalid Mansur (*)	FURG/BR	Chemistry/PH/CO2/XBT
13	Camilla Caetano (**)	UERJ/BR	Chemistry/PH/Alkalinity/CO2
14	Daniel Valla. (*)	SHN/Argentina	CTD/LADCP/XBT
15	Marcela Charo	SHN/Argentina	CTD/Autosal/XBT
16	Raul Guerrero	INIDEP/Argentina	CTD/LACDP
17	Harold Fenco	INIDEP/Argentina	CTD/LADCP
18	Gaston Manta. (*)	UdelaR/Uruguay	CTD/XBT/Autosal
19	Pedro Pena	NOAA/USA	PIES/C-PIES
20	Rigoberto Garcia	NOAA/USA	PIES/C-PIES

(*) Graduate student – (**) Undergrad. student

4. Description of the Equipment

A list of the main instrumental and equipment used to carry out the different activities is given in Table III. Table IV presents technical information and Figures 4 and 5 show visual details of some of the core instruments.

Table III: Equipment used in the SAMBAR_A1

Equipment	Owner	Purpose
Rosette equipped with CTD Sea-Bird 911Plus, with dual sensors for Conductivity, Temperature, Depth, O2 and Fluorescence, and 24 Niskin bottles of 5 liters.	IOUSP	Continuous sampling of C, T, D, O2 and Fluorescence (an indicator for chlorophyll) in the water column and sampling of water for biogeochemical analyses.
Salinometer Autosal Guildline 8400-B	IOUSP	Onboard analyses of salinity of the water samples for evaluating the CTD accuracy
4 (four) inverted eco-sounders with Pressure gauge (PIES).	NOAA	Two of the PIES will be used to replace units that showed sign of malfunctioning during the previous SAMOC cruise. Two other to be kept as spare.
Lowered ADCP or LADCP (installed with the CTD in the Rosette)	IOUSP (I. da Silveira)	Used to carry out a continuous vertical profile of velocity, using an acoustic Doppler current profiler
Benthos acoustic system's deck units and hydrophones	IOUSP & UBA	Telemetry of data stored in the moored PIES/C-PIES and for acoustic release of units that to be replaced.
Vacuum pump GAST	IOUSP	Removal of air from the interior of the PIES/C-PIES, after recovery, service and battery replacement.
XBT launcher & probes	IOUSP	Deployment of XBTs
Titrand model 907	IOUSP	Oxygen analyzer
Centrifuge Excelsa II – Fanen	IOUSP	Preparation of samples to be analyzed
PH-meter	UERJ	Analysis of the water samples PH
PCO2 analyzer	UERJ	Analysis of the CO2 content
Minor equipment and support material	IOUSP	Tools and supplies to support the different operations

Table IV: Technical details of the core instruments

System	Sensor	Model	SN	Maker
CTD	Pressure			Seabird
	Temperature1	SBE3 plus	5606	Seabird
	Condutivity1	SBE 4C	044096	Seabird
	Oxygen1	SBE 43	432414	Seabird
	Fluorometer	ECO-FLRTD	2645	Wet Labs
	Pump 1	SBE S7	056583	Seabird
	Temperature 2	SBE3 plus	5628	Seabird
	Condutivity 2	SBE 4C	044098	Seabird
	Oxygen 2	SBE 43	432416	Seabird
	Pump 2	SBE ST	056642	Seabird
	Altimeter	PSA 916D	57419	Benthos
TERMOSAL	Temperature	SBE 38		Seabird
	Condutivity/temp	SBE 45		Seabird
ADCP	75 KHz	Surveyor	1867	RDI/Teledyne
Salinometer		Autosal	71012	Guildline
C-PIES AA		URI 6.2C	289	Univ. R. Island
C-PIES BB		URI 6.2C	290	Univ. R. Island
C-PIES CC		URI 6.2C	291	Univ. R. Island
XBT probes	Temperature / Depth	Deep Blue		Lockheed Martin
XBT probes	Temperature / Depth	T5		Lockheed Martin

Figure 4: Illustration of some of the instruments used during the campaign. More details in Table III.

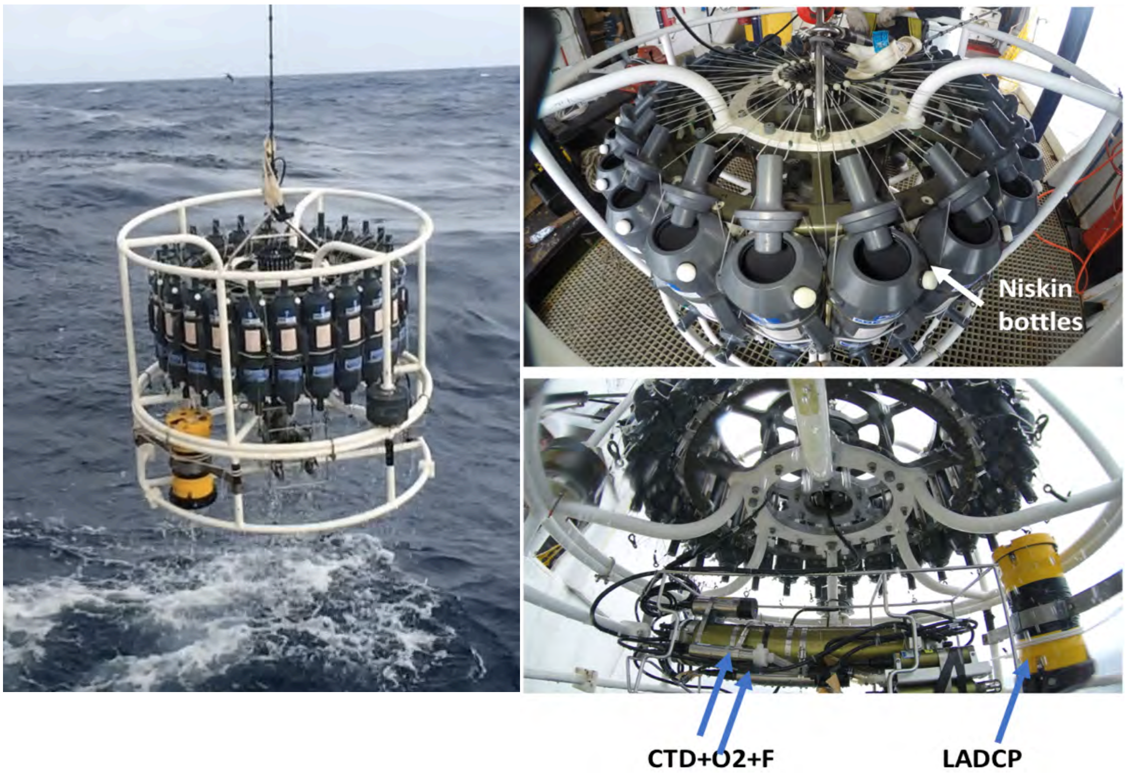


Figure 5: Details of the Rosette system, with 24 five-liter Niskin bottles and mounted CTD & LADCP.

4. Short description of the Daily Activities

4.1 - April 20 to April 23: In transit to SAMBA

The ship departed from Santos at 2:00pm, on April 20th towards the first waypoint (Fig. 3), the mooring site of C-PIES BB (34º 299' S, 48º 30.521' W). This waypoint was reached on April 23 at 3:30pm. During the intervening time, while the different instruments were dully prepared and installed, a series of intensive training sessions on their use and on the analysis of the collected data were given by the specialists onboard (Fig. 6). This was especially important for the young scientists and students, many of them participating for the first time in an oceanographic cruise of this type. Another important event was the "confraternization churrasco", offered by the ship's crew to the scientific team on Sunday, April 22nd.

Fig. 6 – The confraternization barbeque on April 20th and the training session on the use of CTD control console during the test station.

During this transit period, it was also defined the working teams, each composed by experts and trainees and able to operate and analyze the data collected by the different instruments onboard. Table V lists the components of the two groups, which took turns from 12:00 to 24:00 and from 00:00 to 12:00. The Chief Scientist did not follow a defined schedule and the group in charge of the chemical component was not divided in turns. They decided to carry out their tasks in a more dynamical fashion. Also, the two specialists from NOAA were available whenever there was an activity related to the PIES/C-PIES.

Table V: SAM15/SAMBAR_A1 Work Teams

Edmo Campos	
Team Alpha: 12:00 – 24:00H	Team Bravo: 0:00 – 12:00h
Dani Valla (Team Leader/CTD/ADCP)	Raul Guerrero (Team Leader/CTD/SAL)
Marcela Charo (CTD Console)	Gaston Manta (CTD Console)
Mauro Quandt (PIES/CTD)	Harold Fenco (ADCP/CTD)
Wilson Natal (PIES/CTD/Termosal)	Chico Vicentini (PIES/CTD/Termosal)
Fabricio Oliveira (SAL/ADCP)	Carlos Teixeira (SAL/CTD/Biology)
Luciana Kfouri (SAL/Rosette/Water Samples)	Juan Lopez (SAL/Rosette/Water Samples)

Chiara Vieira (Team Leader/Oxygen/Nutrients/Chlorophyll)
Victor Chiozzinni (Oxygen/Nutrients/Chlorophyll)
Ana Beatriz (Oxygen/Nutrients/Chlorophyll)
Camilla Caetano (Alkalinity/Chlorophyll/CO2)
Julia Mansur (Alkalinity/Chlorophyll/CO2)

Rigo Garcia (PIES)
Pedro Pena (PIES)

4.2 - April 23 - The First Station (C-PIES BB)

Site BB was reached on April 23 at 3:40pm. As planned, the first activity in the location was the realization of a CTD station, to train the teams on how to carry out properly the CTD operation, to test the equipment and to find out if any adjustment was needed in the winch system. Following the test CTD station, several attempts to listen the C-PIES BB were made. None was successful. Thus, it was decided to send the release signal. Fortunately this worked and the C-PIES was brought onboard the vessel. After that, the ship was directed towards the second waypoint, the ADCP mooring site.

4.3 Diagnostic of the C-PIES BB malfunction

During the transit form the first to the second waypoint, the C-PIES from BB was open and a full diagnostic was performed (Fig. 7). First, it was found that there was still some battery power left (thus, the successful release and recovery) but had practically no data recorded in its memory card. The instrument stopped recording approximately 6 days after its deployment on Oct, 26, 2016. The retrieved log files were sent by e-mail to the US and, after analysis by specialists at NOAA and the University of Rhode Island, a message was sent to the technicians onboard, with instruction on how to attempt to correct the problem (see Annex III).

Following the instructions, the NOAA and IOUSP technicians on board (Pedro Pena and Rigo Garcia, Mauro Monteiro, Wilson Natal and Francisco Vicentini) made the proper corrections and, after considering all possibilities, a decision was made to redeploy the C-PIES. So, following the original plans, the recovered unit (SN290) was redeployed after recovering SN289 on site AA. After the same procedures, the reconditioned SN289 was eventually re-launched on site BB.

C-PIES AA (SN290) without the hard hat.

Ready to open the glass sphere

Remounting back the system

Ready to re-launch.

Figure 7: After retrieval, C-PIES BB (SN290) was open and a full diagnostic performed. Following instruction from URI, it was reconditioned and eventually redeployed at site AA, with nominal position 34º 30'S, 50º 30'W. The C-PIES originally deployed at Site AA (SN289) was retrieved prior to the launching of SN290.

4.4 Problem with communication

As mentioned earlier in this report, the purchase of 200 units of credit for the use of internet service via satellite was made prior the start of the cruise. In spite of the very restrict and limited use (only by the Captain and the Chief Scientist), after the exchange of communication with the NOAA and the University of Rhode Island, it was realized that the internet credits would not last longer than a couple of days. Urgent request was made for the purchase of more credits, at the project's expense. At the end, a quick look at the communication logs showed that all the credits purchased was just enough for the sending/receiving of a few emails per day and the download of weather reports once every other day. It is important to mention that, during the two weeks of the cruise, none of the participants could browse the internet or send or receive personal emails. The only way of communication was one general messages sent every other day by the ship's Captain addressed to a single of group of recipients indicated by the participants (See Annex IV).

4.5 The recovery of the ADCP and the BPR

On April 24 the ship arrived at the location of the ADCP mooring (34º 18.985'S, 51º 40.648'W) at 01:00pm. A CTD station was performed and, after recovering the instrument, the cruise continued to west, reaching the third waypoint (34º 17.884'S, 51º 42.440'W) at 07:30pm. At this site, the rosette was not launched and, in a quick operation, the bottom pressure recorder was recovered. Both operations were done smoothly, with no casualty (Fig. 8)

Fig. 8: Pictures taken during the operations with the ADCP (left) and the BPR (right). The insert shows a little crab that took a ride from the bottom to the surface, on the BPR.

The only not-expected occurrence happened during the recovery of the BPR. A little critter from the deep decided to take a ride up on the instrument's frame (insert on the top-right of Fig. 8). After being the center of attention for a while, the stowaway was returned to the water. Whether or not it made back to the bottom is still controversial.

4.6 Beginning of the SAMBA-West Hydrographic Section

With the three recovered instruments (C-PIES SN290, ADCP and BPR) onboard, the ship headed toward the westernmost waypoint (33° 15.508'S, 52° 39.078'W. At this site, which was reached at 12:50am (00:50h) on April 25th, a CTD station was performed. Then the ship returned to east, realizing full CTD profiles in each of the following stations. In the shallower stations over the continental shelf, the CTD profiles reached depths around 5 meters above the sea floor. In the deeper station, the minimum distance to the bottom was kept around 10 meters. Table VI presents a detailed description of the CTD stations and activities carried out in each of the waypoints.

4.7 XBT launching

Starting at the mid-point between CTD stations 7 and 8, XBT probes were launched in between each pair of adjacent CTD stations. Two models of probes were deployed: Deep Blue, with maximum reach of 760 m in regions shallower than 750 meters, and T-5, with nominal reach of 1800m in the deeper stations (Fig. 9). More details in Table VII.

Fig. 9 – Deep Blue and T5 XBTs

4.8 Redeployment of the BPR and ADCP

The NOc Alpha-Crucis arrived back at the BPR mooring site on April 25, 04:52pm. In this position, a full depth CTD station and the redeployment of the BPR were carried out without any problem. Immediately the ship went on to the next waypoint, where another CTD profile was obtained and the ADCP deployed again on the sea floor.

Table VI: Detailed description of the entire cruise

Esta	DateGMT	TimeGMT	latdg	latmin	lat	ondeg	lonmin	long	dist (nm	dist (km	um(nm)	Depth	Ref
Santos	20-Apr-18	16:45	23	58	-23.9667	46	18	-45.7000	0.0	0.0	0.0		Port of Santos
1	23-Apr-18	19:23	34	29.43	-34.4905	48	29.93	-48.4988	648.2	1200.5	648.2	4176	CTD 1 on site of CPIES BB
	23-Apr-18	22:15	34	29.733	-34.4956	48	30.206	-48.5034	0.4	0.7	648.6	4140	Recovery of CPIES BB
2	24-Apr-18	16:15	34	19.02	-34.3170	51	40.65	-51.6775	157.5	291.7	806.1	397	CTD 2
	24-Apr-18	17:22	34	19.271	-34.3212	51	41.103	-51.6851	0.5	0.8	806.5	377	Recovery of ADCP
	24-Apr-18	18:20	34	17.993	-34.2999	51	42.733	-51.7122	1.9	3.4	808.4	165	Recovery of BPR
3	25-Apr-18	3:52	33	15.3	-33.2550	52	39.3	-52.6550	78.4	145.1	886.8	15	Start CTD Section - CTD 3 Albardao
4	25-Apr-18	5:52	33	23.52	-33.3920	52	31.88	-52.5313	10.3	19.1	897.1	18	CTD 4
5	25-Apr-18	8:22	33	34.63	-33.5772	52	20.05	-52.3342	14.9	27.5	911.9	37	CTD 5
6	25-Apr-18	9:59	33	41.98	-33.6997	52	12.03	-52.2005	9.9	18.4	921.8	74	CTD 6
7	25-Apr-18	12:24	33	50.08	-33.8347	52	4.32	-52.0720	10.3	19.1	932.2	45	CTD 7
X1	25-Apr-18	13:30	33	56.01	-33.9335	51	59.6	-51.9933	7.1	13.2	939.3	56	XBT 1, Deep Blue (DB)
8	25-Apr-18	15:48	33	59.88	-33.9980	51	56.07	-51.9345	4.9	9.0	944.1	68	CTD 8
X2	25-Apr-18	16:52	34	5.05	-34.0842	51	52.97	-51.8828	5.8	10.7	949.9	91	XBT 2,DB
9	25-Apr-18	17:59	34	10.23	-34.1705	51	49.74	-51.8290	5.8	10.8	955.7	128	CTD 9
X3	25-Apr-18	19:22	34	16.23	-34.2705	51	44.33	-51.7388	7.5	13.9	963.2	182	XBT 3, DB
10	25-Apr-18	19:50	34	17.91	-34.2985	51	42.4	-51.7067	2.3	4.3	965.5	165	CTD 10 at the site of the BPR
	25-Apr-18	20:22			-34.3005			-51.7061	0.1	0.2	965.7	166	mooringn of BPR
11	25-Apr-18	20:54	34	19.07	-34.3178	51	40.69	-51.6782	1.7	3.2	967.4	399	CTD 11 at the ADCP site
	25-Apr-18	22:02			-34.3161			-51.6778	0.1	0.2	967.5	391	Mooring of ADCP
12	25-Apr-18	22:48	34	21.84	-34.3640	51	37.88	-51.6313	3.7	6.8	971.2	758	CTD 12
X4	26-Apr-18	0:13	34	25.99	-34.4332	51	33.76	-51.5627	5.4	9.9	976.5	1097	XBT 4, DB
13	26-Apr-18	1:13	34	29.8	-34.4967	51	29.9	-51.4983	5.0	9.2	981.5	1360	CTD 13 on site of PIES A / Telemetry
X5	26-Apr-18	0:11	34	29.94	-34.4990	51	14.11	-51.2352	13.0	24.1	994.5	1952	XBT5, T5
14	26-Apr-18	11:44	34	29.82	-34.4970	50	59.77	-50.9962	11.8	21.9	1006.3	2536	CTD 14
X6	26-Apr-18	15:00	34	30.11	-34.5018	50	45.37	-50.7562	11.9	22.0	1018.2	2797	XBT 6,T5
15	26-Apr-18	16:55	34	29.92	-34.4987	50	31.16	-50.5193	11.7	21.7	1029.9	2876	CTD 15 at site of CPIES AA
	26-Apr-18	20:36	34	30.307	-34.5051	50	31.976	-50.5329	0.8	1.4	1030.7		Recovery of CPIES SN289 (AA)
	26-Apr-18	21:01			-34.4996			-50.5003	1.6	3.1	1032.3	3272	Mooring of CPIES at AA (S/N 290)
X7	27-Apr-18	0:13	34	30.02	-34.5003	50	14.86	-50.2477	12.5	23.1	1044.8	3005	XBT 7,T5
16	27-Apr-18	2:02	34	29.96	-34.4993	49	59.75	-49.9958	12.5	23.1	1057.3	3148	CTD 16
X8	27-Apr-18	6:21	34	30.11	-34.5018	49	45.52	-49.7587	11.7	21.7	1069.0	3354	XBT 8, T5
17	27-Apr-18	8:12	34	29.94	-34.4990	49	30.05	-49.5008	12.8	23.6	1081.8	3503	CTD 17 at site PIES B
	27-Apr-18	10:17	34	30.042	-34.5007	49	30	-49.5000	0.1	0.2	1081.9	3347	Mooring of PIES B (S/N 401)
X9	27-Apr-18	16:44	34	29.98	-34.4997	49	14.91	-49.2485	12.4	23.0	1094.3	3634	XBT 9, T5
18	27-Apr-18	18:21	34	29.86	-34.4977	48	59.76	-48.9960	12.5	23.1	1106.8	3832	CTD 18
X10	27-Apr-18	22:52	34	29.62	-34.4937	48	44.61	-48.7435	12.5	23.1	1119.3	3990	XBT 10,T5
	28-Apr-18	0:31	34	29.94852	-34.4991	48	30.04158	-48.5007	0.4	0.7	1132.1	4156	Mooring BB (S/N 289)
19	28-Apr-18	0:50	34	29.93	-34.4988	48	29.57	-48.4928	12.4	23.0	1131.7	4162	CTD 19 at site BB
X11	28-Apr-18	5:02	34	29.93	-34.4988	48	15.56	-48.2593	11.9	22.1	1144.0	4212	XBT 11,T5
20	28-Apr-18	6:45	34	29.96	-34.4993	48	0.15	-48.0025	12.7	23.5	1156.7	4357	CTD 20
X12	28-Apr-18	11:24	34	29.91	-34.4985	47	45.33	-47.7555	12.2	22.6	1168.9	4476	XBT 12, T5
21	28-Apr-18	13:14	34	30.21	-34.5035	47	29.78	-47.4963	12.8	23.7	1181.7	4553	CTD 21 at site C / Telemetry
X13	28-Apr-18	20.16	34	29.92	-34.4987	47	14.88	-47.2480	12.3	22.7	1194.0	4590	XBT 13,T5
22	28-Apr-18	22:05	34	29.82	-34.4970	47	0.02	-47.0003	12.2	22.7	1206.3	4603	CTD 22
X14	29-Apr-18	2:41	34	30.12	-34.5020	46	44.75	-46.7458	12.6	23.3	1218.9	4597	XBT 14,T5
23	29-Apr-18	4:15	34	30.2	-34.5033	46	29.66	-46.4943	12.4	23.0	1231.3	4643	CTD 23
X15	29-Apr-18	9:18	34	30.05	-34.5008	46	15.01	-46.2502	12.1	22.4	1243.4	4712	XBT 15,T5
24	29-Apr-18	11:09	34	29.82	-34.4970	45	59.53	-45.9922	12.8	23.6	1256.1	4744	CTD 24
X16	29-Apr-18	15:25	34	29.98	-34.4997	45	44.77	-45.7462	12.2	22.5	1268.3	4762	XBT 16,T5
25	29-Apr-18	17:00	34	29.81	-34.4968	45	29.87	-45.4978	12.3	22.7	1280.6	4758	CTD 25
X17	29-Apr-18	21:54	34	30.02	-34.5003	45	14.92	-45.2487	12.3	22.8	1292.9	4760	XBT 17,T5
26	29-Apr-18	23:38	34	29.91	-34.4985	44	59.75	-44.9958	12.5	23.2	1305.4	4764	CTD 26
X18	30-Apr-18	3:59	34	30.05	-34.5008	44	44.82	-44.7470	12.3	22.8	1317.7	4768	XBT 18,T5
	30-Apr-18	7:53	34	30.185	-34.5031	44	30.149	-44.5025	12.1	22.4	1329.8		Recovery PIES D
	30-Apr-18	8:10	34	30.008	-34.5001	44	30.009	-44.5002	0.2	0.4	1330.0	4752	Redeployment PIES D (S/N 282)
27	30-Apr-18	8:35	34	29.74	-34.4957	44	30.1	-44.5017	12.1	22.5	1329.8	4757	CTD 27
X19	30-Apr-18	15:25	34	4.79	-34.0798	44	34.3	-44.5717	25.6	47.5	1355.4	4710	XBT 19 ,T5
X20	30-Apr-18	18:49	33	39.49	-33.6582	44	38.64	-44.6440	51.0	94.5	1381.0	4194	XBT 20, T5
X21	30-Apr-18	22:04	33	14.27	-33.2378	44	42.87	-44.7145	76.2	141.1	1406.1	4175	XBT 21,T5
X22	1-May-18	1:29	32	48.22	-32.8037	44	47.93	-44.7988	77.4	143.4	1432.8	4182	XBT 22, failed 2 T5, launched DB
X23	1-May-18	4:23	32	24.43	-32.4072	44	52.77	-44.8795	76.0	140.7	1457.0	4025	XBT 23 T5 config DB, depth corr. for T5
X24	1-May-18	7:59	31	58.5	-31.9750	44	57.6	-44.9600	76.8	142.2	1482.8	4115	XBT 24, T5
X25	1-May-18	11:15	31	33.09	-31.5515	45	2.47	-45.0412	76.1	141.0	1509.0	3606	XBT 25, T5
X26	1-May-18	14:29	31	8:18	-31.0058	45	7.5	-45.1250	85.0	157.4	1542.0	3572	XBT 26, T5
X27	1-May-18	17:38	30	42.65	-30.7108	45	12.04	-45.2007	76.8	142.3	1559.7	2372	XBT 27, T5
X28	1-May-18	20:41	30	17.67	-30.2945	45	16.43	-45.2738	76.4	141.4	1585.3	3275	XBT 28, T5
X29	1-May-18	23:45	29	51.92	-29.8653	45	20.77	-45.3462	69.4	128.5	1611.4	3523	XBT 29, T5
X30	2-May-18	2:39	29	26.26	-29.4377	45	24.64	-45.4107	77.2	142.9	1636.8	3519	XBT 30, T5
X31	2-May-18	5:32	29	1.74	-29.0290	45	28.27	-45.4712	76.6	141.9	1662.0	3336	XBT 31, T5
X32	2-May-18	8:29	28	36.17	-28.6028	45	32.01	-45.5335	76.4	141.5	1687.8	2978	XBT 32,T5
X33	2-May-18	10:40	28	17.5	-28.2917	45	34.9	-45.5817	69.3	128.4	1706.2	2875	XBT 33,T5
X34	2-May-18	12:50	27	58.72	-27.9787	45	38.35	-45.6392	63.6	117.9	1725.6	2755	XBT 34,T5
X35	2-May-18	14:52	27	40.43	-27.6738	45	41	-45.6833	56.3	104.3	1744.1	2452	XBT 35,T5
X36	2-May-18	17:02	27	21.96	-27.3660	45	43.69	-45.7282	56.1	103.9	1762.3	2182	XBT 36,T5
X37	2-May-18	19:07	27	3.23	-27.0538	45	46.61	-45.7768	56.0	103.7	1781.6	1993	XBT 37,T5
X38	2-May-18	21:33	26	44.74	-26.7457	45	49.46	-45.8243	56.2	104.1	1800.3	1349	XBT 38,T5
X39	2-May-18	23:52	26	26.7	-26.4450	45	52.61	-45.8768	55.8	103.4	1818.1	657	XBT 39,DB
X40	3-May-18	2:12	26	7.88	-26.1313	45	56.44	-45.9407	56.0	103.8	1837.6	422	XBT 40,DB
X41	3-May-18	4:23	25	50.1	-25.8350	45	59.61	-45.9935	55.4	102.6	1855.7	169	XBT 41,DB
X42	3-May-18	6:50	25	30.5	-25.5083	46	3.4	-46.0567	57.0	105.6	1875.1	122	XBT 42,DB
X43	3-May-18	9:09	25	12.05	-25.2008	46	6.8	-46.1133	56.6	104.8	1894.2	93	XBT 43,DB
X44	3-May-18	11:34	24	53.91	-24.8985	46	10.39	-46.1732	57.0	105.6	1912.7	73	XBT 44,DB
X45	3-May-18	14:01	24	35.54	-24.5923	46	14.39	-46.2398	55.9	103.4	1931.0	49	XBT 45,DB

Table VII: Details of the XBT stations along the SAMBA

Station #	Date	Hour	Longitude (º)	Latitude (º)	Max. depth (m)	XBT type
1	04/25/2018	13:30	51.99	33.93	57	Deep Blue
2	04/25/2018	16:52	51.88	34.08	92	Deep Blue
3	04/25/2018	19:22	51.74	34.27	183	Deep Blue
4	04/26/2018	00:13	51.56	34.43	931	Deep Blue
5	04/26/2018	09:59	51.24	34.5	1645	T-5
6	04/26/2018	15:00	50.76	34.5	2218	T-5
7	04/27/2018	00:11	50.25	34.5	1975	T-5
8	04/27/2018	06:21	49.76	34.5	1765	T-5
9	04/27/2018	16:44	49.25	34.5	2049	T-5
10	04/27/2018	22:52	48.74	34.49	2111	T-5
11	04/28/2018	05:02	48.26	34.5	2218	T-5
12	04/28/2018	11:24	47.76	34.5	2219	T-5
13	04/28/2018	20:16	47.25	34.5	1951	T-5
14	04/29/2018	02:41	46.75	34.5	1967	T-5
15	04/29/2018	09:18	46.25	34.5	2210	T-5
16	04/29/2018	15:25	45.75	34.5	2230	T-5
17	04/29/2018	21:54	45.25	30.5	2213	T-5
18	04/30/2018	03:59	44.75	34.5	2232	T-5

4.9 Successful Data Telemetry from PIES A

On April 25th, at 10:15pm, the ship arrived at the location of PIES A. First, a full depth CTD station was performed and, following, the data telemetry started. Because of the strong currents, the operation lasted for over 4.5 hours but, in the end, all data was retrieved.

Up to this day, the weather conditions were highly favorably and the weather forecast downloaded from CPTEC showed no alarming change of conditions for the follwoing few days. So, up to this date, no change in the original plan was foreseen.

4.10 Recuperation of C-PIES SN 289 and Redeployment of SN290 at site AA.

At 2:07 pm of April 26th, the sixth day of the cruise and of continuous good weather, the ship arrived at the site AA (34º 29.773'S, 50º 31.516'W), where C-PIES SN289 was moored in Dec/2012. Again, first, a full CTD station was realized. Following, after a couple of attempts to listen to the bottom moored instrument, the release signal was sent and 90 minutes later the C-PIES SN289

Fig. 10: C-PIES SN289 recovered from site AA. Relaunched on site BB.

was onboard (Fig. 10)[4]. The ship was again positioned at the nominal location of site AA (34º 30'S, 50º 30'W) and the reconditioned C-PIES that had been recovered on site BB (SN 290) was relaunched (Fig. 11). The ship waited on site until the instrument arrived at the bottom (~ one hour) and then a successful data telemetry was carried out, just to confirm if the IES was in operation. After that, at the ship went on to the next station, where only a CTD station was carried out.

Fig. 11: C-PIES SN290, ready to be launched site AA, and the PIES team: Mauro Pereira, Pedro Pena, Edmo Campos, Rigo Garcia and Chico Vicentini.

4.11 – Operation on site B

The ship arrived at site B, where PIES SN244 was anchored in 2015, in the early morning of April 27 (5:05am). Because during the past cruise (SAM14) this instrument completely failed to respond to any form of acoustic communication, a new instrument (PIES SN401) had been brought from the US for replacement. The same way as in the previous stations, first a full depth CTD station was successfully conducted. Then, after a last unsuccessful attempt to communicate with the silent PIES, the release signal was sent and the ship's position was maintained for about 1,5 hour. After that time, since there was no signal of the instrument at the surface, a decision was made to forget it and deploy the new PIES unit, SN401. Again, after waiting for the instrument to reach the ocean floor, a test telemetry was conducted successfully. The ship departed from site B to the next station at 12:05pm.

4.12 – Design of alternative plans in case of bad weather

After finishing the operations on site B, an analysis of the CPTEC's wave forecast for the following days indicated possible change of weather conditions by the end of April or beginning of May. Because the last waypoint, on Site D (34.5ºS, 44.5ºW), was expected to be reached around midnight on April 30th, some alternative plans were designed. The last station would require around 9 hours of operation, due to a very deep CTD cast (~ 4740 meters) and the conduction of data telemetry for PIES, or for recovery and redeployment. To minimize the problems in the event of bad weather during the work,

[4] Time-Capsule: The original mooring happened a few days after the final game of the "2012 Libertadores Cup". One of the technicians onboard decided register the fact for posterity.

one or two of the remaining CTD stations could be skipped. The decision was to continue with the original design (Plan A) if the weather would continue well behaved. On the contrary, one of two alternative scenarios (Plan B or Plan C) would be adopted.

4.13 Redeployment of C-PIES SN289 on Site BB

Around 11:00pm of April 27th, the ship arrived again at site BB. At this position, the refurbished C-PIES, which had been recovered in site AA, was redeployed. It is important to register that this C-PIES showed the same problem as the previous one. That is, in spite of some battery power left, data was recorded for only a few days after the deployment in 2006. It was then reconfigured, following the instructions, but with a small difference. After the deployment of SN290 on site AA, an email from URI arrived with the latest version of the firmware. It was too late for SN290 but we managed to upgrade the firmware for SN289. After the launching of the CPIES, the CTD station number 19 was performed on site BB.

4.14 Data Telemetry on Site C

After the realization of a CTD station half-way from site BB, the ship arrived at Site C, at about 10:00am on April 28th. An attempt to "talk" with the instrument was successful and, because the sea was so well behaved, it was decided to conduct the data telemetry in parallel with the CTD operation. Everything worked fine and at least four hours was saved in that waypoint.

A second unexpected event happened on Saturday, April 28th. Suddenly, a small bird was found wandering in the ship. It was somewhat disoriented and distressed. While finding gooney birds more than 300 km away from the coast is not uncommon, that is not the case for such a small bird. This little guy was scared and thirsty, for it refused water offered by the crew but, as soon as the Rosette came back onboard after its launching at site CC, the bird was caught on camera drinking water from the CTD instrument. Probably that was fresh water used to wash the instrument or condensed water due to the instrument's cooler temperature (Fig. 12). Incidentally, the CTD is made by the Seabird company!

Fig. 12: A sea bird quenching its thirst with water condensed on a Seabird CTD. This stowaway was found onboard near site CC, more than 300km away from any land.

4.15 CTD stations between Sites C and D.

The CPIES CC, that was moored midway between PIES C and D in 2012, was recovered in October 2016, due to malfunction. That instrument is currently being refitted and planned to be redeployed in October 2018. So, only CTD stations were conducted in between sites C and D. In the original cruise design (“Plan A”), five full-depth CTD stations were planned. As mentioned before, in case of bad weather, we had considered the possibility of skip one (“Plan B”) or two (“Plan C”) of these stations. In the end, the weather conditions continued highly favorable and there was no need for an alternative plan. All five stations between C and D were successfully conducted.

4.16 Site D - The Last CTD Station

At 2:00am of Monday, April 29th, the ship finally arrived at the last waypoint, the site of PIES D (SN187). Because in the previous cruise, most likely due to more severe weather condition, communication with the PIES had failed, a complete equipment was brought to replace it. However, just to make sure, upon arrival at the waypoint, the first action was an attempt to do a data telemetry. The instrument responded. However, the data being received was too noisy and erratic. It was then decided to recover the instrument and deploy the new PIES (SN282). After being brought onboard, a preliminary diagnostic showed some kind of not yet identified problem with the stored data.

After the PIES recovery/deployment operation, the CTD was launched for the last time in the SAMBAR_A1 cruise. Complete success! All 27 stations projected in the original plan were performed, without any problem. After having the Rosette back on board, the ship started the trip back to Santos.

4.17 The “AX-SAMBA” XBT line

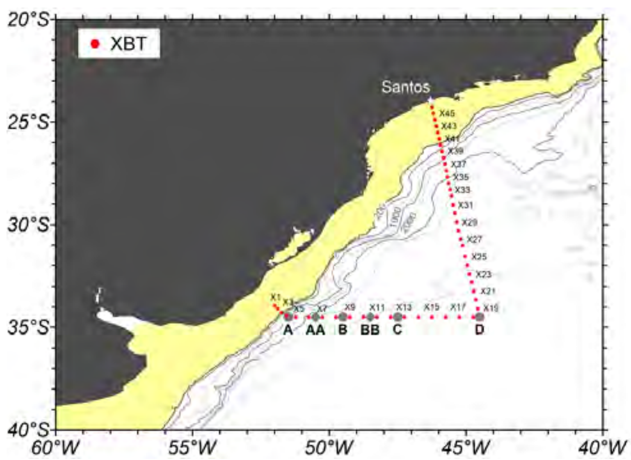


Fig. 13: All XBT stations: 18 along SAMBA and 28 along the track from Site D to Santos.

As pointed out earlier in this Report, 19 XBT probes were launched in between pairs of CTD stations, starting from the mid-point between Stations 7 and 8, on the continental shelf. After the completion of the SAMBA Section, at Site D, it was decided to continue launching XBTs on the way back to Santos. In this new section, dubbed (just for fun) as the “AX-SAMBA”, a total of 28 T-5 probes were deployed at the points listed in Tables VI and VII. and illustrated in Fig. 13. The purpose of this activity was to obtain a high resolution temperature section to investigate the vertical structure of the water masses in the upper 1800+ meters of the water column. T-5 XBT probes were used in the regions deeper that 700 m. Deep Blue units were deployed in the shallower region.

5. Detailed Description of the Research Activities

In this section, the research activities are described according to reports prepared by the researchers leading each of them.

5.1 LADCP (D. Valla & H. Fenco)

Instrument Setup and deployment

A single, brand new TRDI 300kHz Workhorse (WH, S/N 24475) aluminum cased Acoustic Doppler Current Profiler (ADCP) was kindly made available by I. da Silveira, for use on SAM15-SAMBAR-A01 to collect full-depth horizontal velocity profiles during CTD stations. The ADCP was generously lent by Ilson da Silveira. The unit was mounted in a downward looking orientation (Lowered-ADCP or LADCP) on a side of the CTD frame using a metal collar (Figure 14), taking care not to interfere with the closing of the Niskin bottle. After station 7, the LADCP was repositioned because turbulence was detected near the water intake of the CTD temperature and salinity sensors.

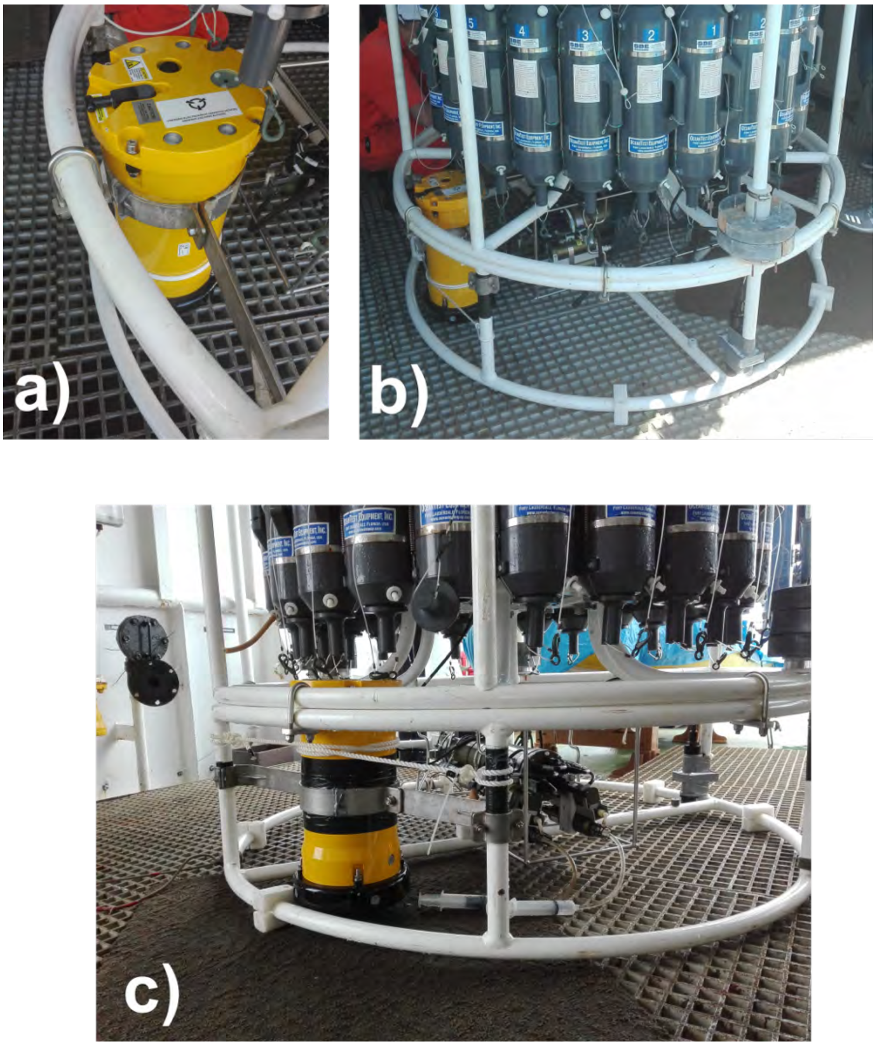


Figure 14: LADCP mounting. **a-b)** Original position. **c)** After moving it away from the CTD water intake.

The WH unit was programmed to collect a profile/ensemble per second of a variable range depending on the station depth. Two separate configurations were used during SAM15: the standard 20 x 8 m bin configuration was used between the stations 1-2, 9-27 (configuration file *wh300_dn.cmd*) while a 20 x 4m bin configuration was used between stations 3-8 (configuration file *wh300_dn_shallow.cmd*). The "blank after transmit" (in essence, the distance in cm between the LADCP transducer and the first bin) was set to 0 for all LADCP casts. The data was collected in beam coordinates and rotated to earth coordinates in the post-processing stage. The instrument was connected to a laptop with a Windows 10 OS using a RS-232/USB converter to set up the deployment. The software "BBTalk" developed by TRDI was used to communicate with the unit. After the cast the unit was reconnected to download the data using a 42 V power source to avoid draining the batteries. The list of commands used to deploy the unit are presented in Annex 1. Table VIII summarizes the bin configuration for each LADCP cast during the cruise.

Table VIII: Bin configuration during SAM15-SAMBAR-01A

Stations	bins per ensamble	bins thickness	Nominal range
3-8	20	4m	80m
1-2, 9-27	20	8m	160m

LADCP calibration

A fresh new, demagnetized battery pack was installed in the ADCP before sailing. The ADCP battery is composed of 28 "D" alkaline batteries generating 42V. Before mounting the unit onto the CTD frame the internal gyro was tested to check for drifts. Because the gyro test before calibration was higher than 5º (the test threw an error of 6.9º), a "Hard and Soft Iron Calibration" was conducted according to the manufacture specifications (see Figure 15). After the calibration, a new drift test was conducted with a resulting 0.7º error in the ADCP internal gyro. Because the ferromagnetic material nearby the LADCP may alter the magnetic field in the vicinity of the LADCP, an additional test of the gyro drift was conducted on deck once the package was ready (Figure 15). The two cranes installed on board the Alpha Cruice were used to move the CTD package to deck and hanging it for testing. The resulting drift was 1.8º, hence, we conclude the material sorrounding the LADCP do not affect its performance and an additional calibration was not required. A second test was performed on deck to check for gyro drifts after the cruise.

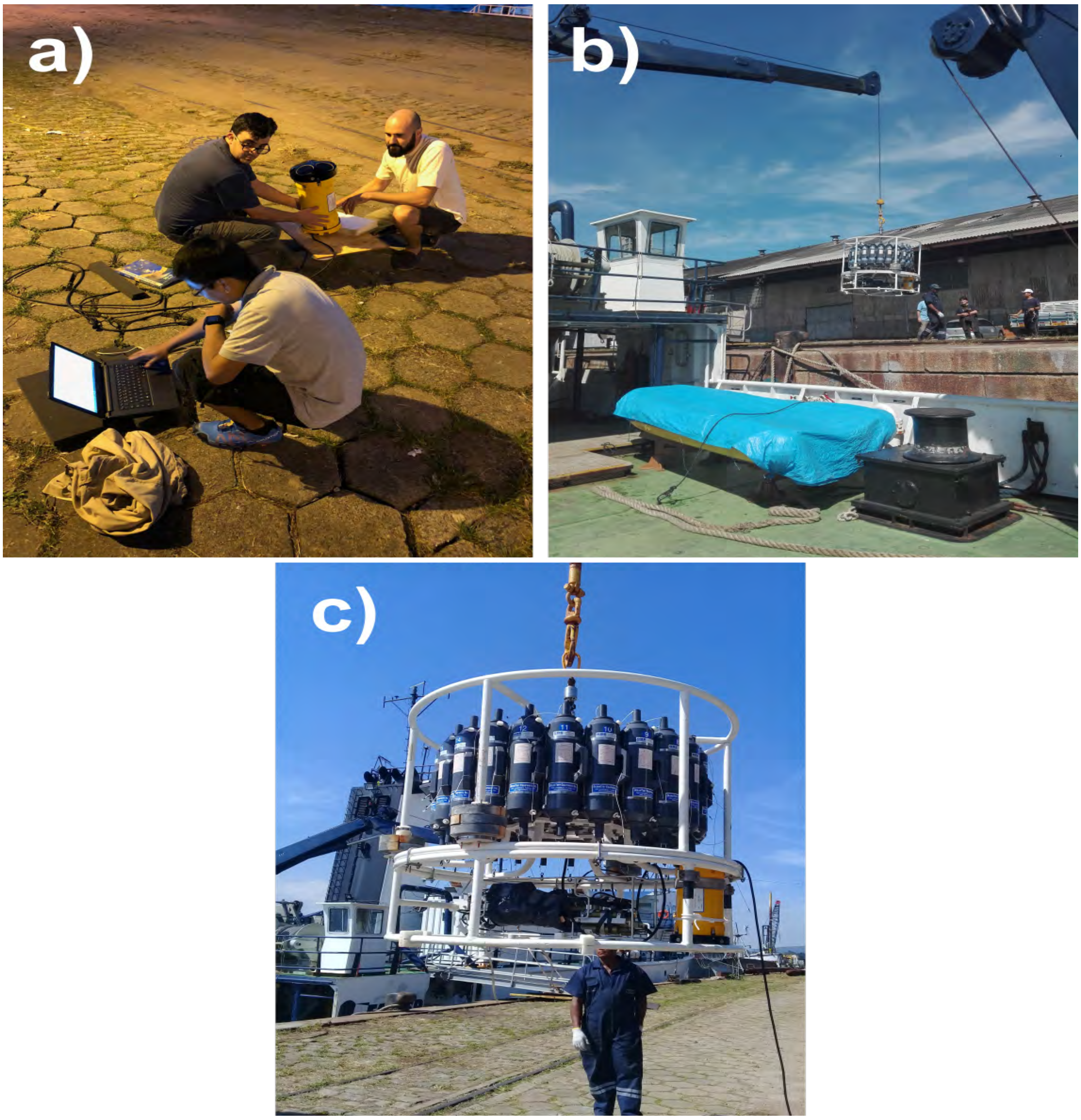


Figure 15: Pre-cruise LADCP calibration. **a)** LADCP calibration on deck before mounting in the CTD frame. **b-c)** LADCP internal gyro testing after mounting.

Data processing

The station data were processed using the Lamont-Doherty Earth Observatory (LDEO) software package (Thurnherr, 2016), which uses an inverse method to calculate velocity profiles, optionally including LADCP bottom tracking and/or VMADCP upper ocean velocities as constraints (see Figure 16 for an example profile). In addition to the horizontal velocity profile the IX software also provides a set of useful auxiliary information such as CTD-derived temperature, salinity and sound profiles, GPS time series used to compute the ship drift during the station or LADCP attitude and heading data. LDEO IX.12 processing on board was performed using only ship navigation and bottom tracking in order to compare the results with the velocity profile collected with the vessel-mounted ADCP during the cast. In order to successfully process the LADCP cast, a 1Hz binned CTD profile needs to be fed to the software. The CTD file must have at least latitude, longitude and time data (for example, julian days or time elapsed in seconds) as well as temperature and salinity data.

Time base for the IX suite.

As mentioned before, the IX software requires CTD data together with a navigational data source, therefore a precise synchronization between LADCP and CTD data is required during the processing. The IX software computes the lag between the two data sets by comparing the vertical velocity of the package measured by the LADCP and the vertical velocity estimated from the CTD pressure time series. It has been previously noticed that using the NMEA *time elapsed* format (in seconds) may lead to spurious lags when calling the script *bestlag.m* (which is used to find the best lag between the two times series). Since NMEA time is recorded into the CTD file, the Year Day format is used as time base for the IX processing. Increasing lags were observed towards the end of the cruise, with a maximum lag of 6 seconds needed to processed station 27. Further analysis is require to determine if this is due to a drift in the LADCP internal clock.

Instrument performance

Because the LADCP SN 24475 was used for its first time during SAM15, a general performance test was conducted after every LADCP cast. In what follows we will briefly address some general comments on these.

Beams performance

IX software provides diagnostic plots of target strength in dB and correlation for the processed cast, which can be found in the two bottom panels in IX “Figure 16”. These target strength and correlation profiles represent an average of the full water column. All 27 LADCP casts showed good beam performance for the four beams. An example figure for station #25 is shown in Figure 17.

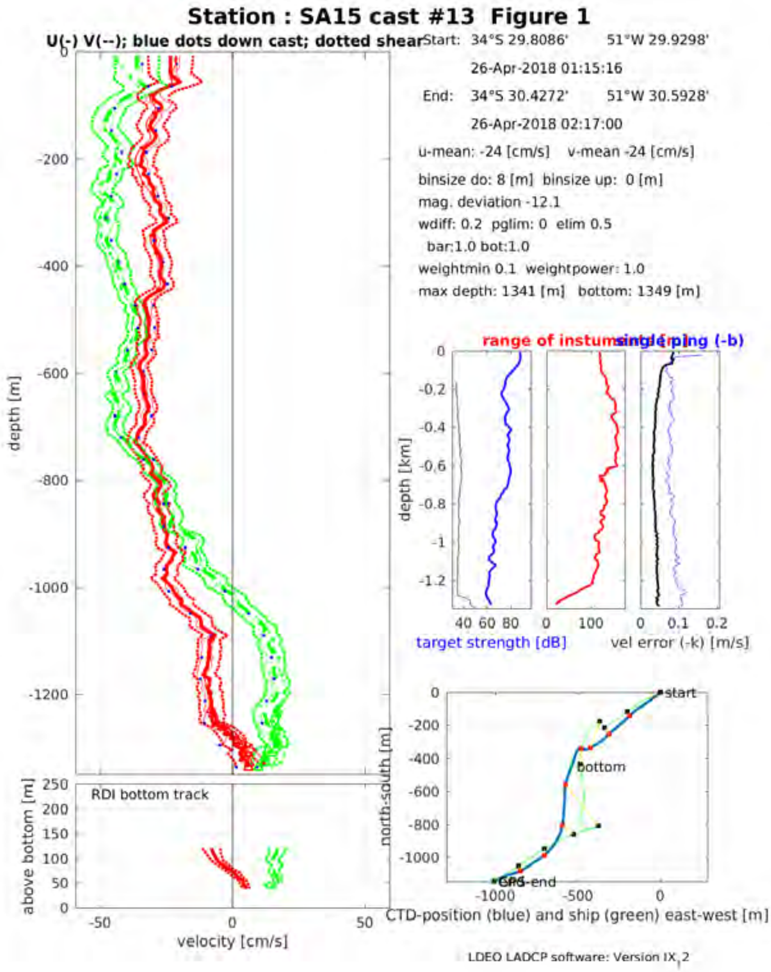


Figure 16: Post-processing results for LADCP cast #13.

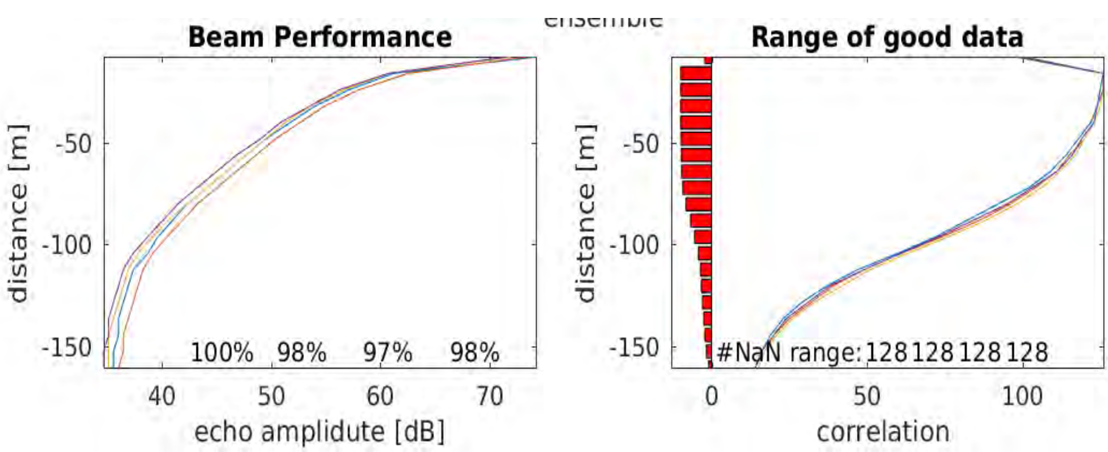


Figure 17: Averaged echo amplitude (left) y and beam correlation for LADCP station #25 computed with the IX software.

Ambient Temperature Performance

Using the IX software processed data, ambient temperature and CTD temperature profiles were compared in order to assess the performance of the external thermistor on the WH unit. Although ADCP thermistor has a slower response compared to the CTD temperature sensor, the two profiles matched quite well for all profiles. Figure 18 show and example for station 25.

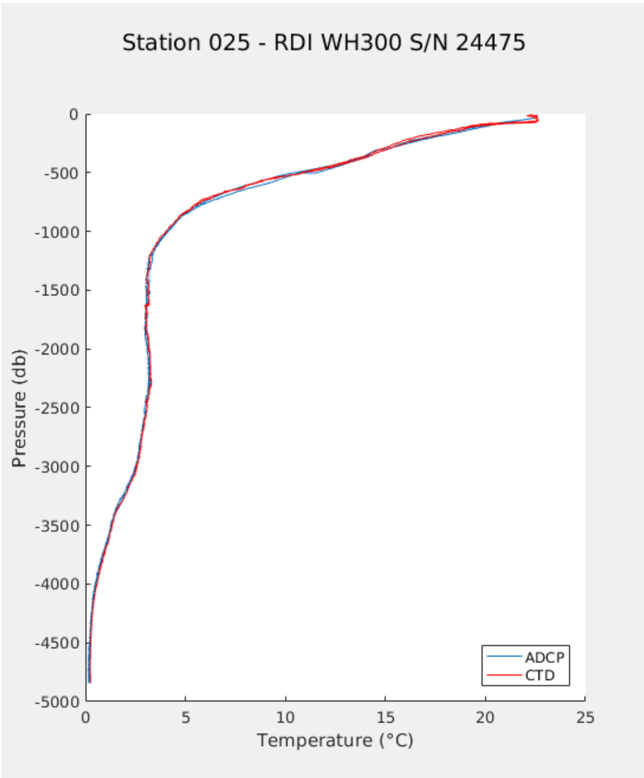


Figure 18: Temperature measurements collected by the external termistor installed in the WH unit compared to the primary CTD temperature sensor for LADCP station 25.

6.3 - Battery pack.

The battery voltage is stored in the binary file during the LADCP cast. This used by the IX software to produce a warning if the battery voltage drops below 42 V (IX "Figure 11"). As a reference, Table IX shows the battery pack usage together with the voltage reported by the IX software. After CTD station #25, the LADCP post processing showed a battery voltage of 34 V. The battery pack was replaced with a fresh, demagnetized one. This was used at stations 26 and 27 only, therefore, we estimate this battery pack could be used for at least about 20 extra hours.

Table IX. LADCP battery pack usage during SAM15/SAMBARA_1. Also indicated are the dates for the first and last ensembles of each cast.

Station	First Ensamble (MM/DD/YYY)	Last Ensamble (MM/DD/YYY)	Battery Hours	Total Battery Hours	IX Battery Usage
001	04/23/2018 19:19	04/23/2018 20:54:55	1.6	1.6	41.4
002	04/24/2018 16:14	04/24/2018 16:45:43	1.5	3.1	39.1
003	04/25/2018 03:37	04/25/2018 04:05:43	0.5	3.6	39.1
004	04/25/2018 05:43	04/25/2018 06:07:17	0.4	4.0	39.1
005	04/25/2018 07:59	04/25/2018 08:37:46	0.6	4.6	39.6
006	04/25/2018 09:52	04/25/2018 10:20:53	0.5	5.1	45.4
007	04/25/2018 11:46	04/25/2018 12:37:55	0.8	5.9	48.4
008	04/25/2018 15:25	04/25/2018 16:02:44	0.6	6.6	44.3
009	04/25/2018 17:43	04/25/2018 18:20:10	0.6	7.2	41.4
010	04/25/2018 19:46	04/25/2018 20:16:31	0.5	7.7	39.9
011	04/25/2018 20:51	04/25/2018 21:25:56	0.6	8.2	37.4
012	04/25/2018 22:38	04/25/2018 23:37:47	1.0	9.2	38.6
013	04/26/2018 01:05	04/26/2018 02:22:55	1.3	10.5	38.6
014	04/26/2018 11:33	04/26/2018 13:35:54	2.0	12.5	38.8
015	04/26/2018 16:46	04/26/2018 19:19:57	2.6	15.1	38.2
016	04/27/2018 01:52	04/27/2018 04:34:22	2.7	17.8	37.9
017	04/27/2018 08:03	04/27/2018 10:52:38	2.8	20.6	37.6
018	04/27/2018 18:11	04/27/2018 21:06:09	2.9	23.5	37.3
019	04/28/2018 00:35	04/28/2018 03:29:27	2.9	26.4	36.9
020	04/28/2018 06:37	04/28/2018 09:57:03	3.3	29.7	36.5
021	04/28/2018 12:59	04/28/2018 16:19:16	3.3	33.1	36.3
022	04/28/2018 22:00	04/29/2018 00:59:17	3.0	36.0	36.2
023	04/29/2018 04:05	04/29/2018 07:47:19	3.7	39.7	35.7
024	04/29/2018 10:50	04/29/2018 14:03:26	3.2	42.9	35.6
025	04/29/2018 16:46	04/29/2018 20:17:13	3.3	**46.3**	35.3
Battery Change					
026	04/29/2018 23:23	04/30/2018 02:32:07	3.1	3.1	40.5
027	04/30/2018 08:15	04/30/2018 11:39:22	3.4	**6.5**	39.3

After the completion of all CTD/LADCP stations, a preliminary processing of the data was carried out. Figure 19 illustrates the vertical sections of Temperatura, Salinity, O2 and along-shore velocity (velocity projected to axis parallel to the bathymetry, ~43^{o} respect to North)

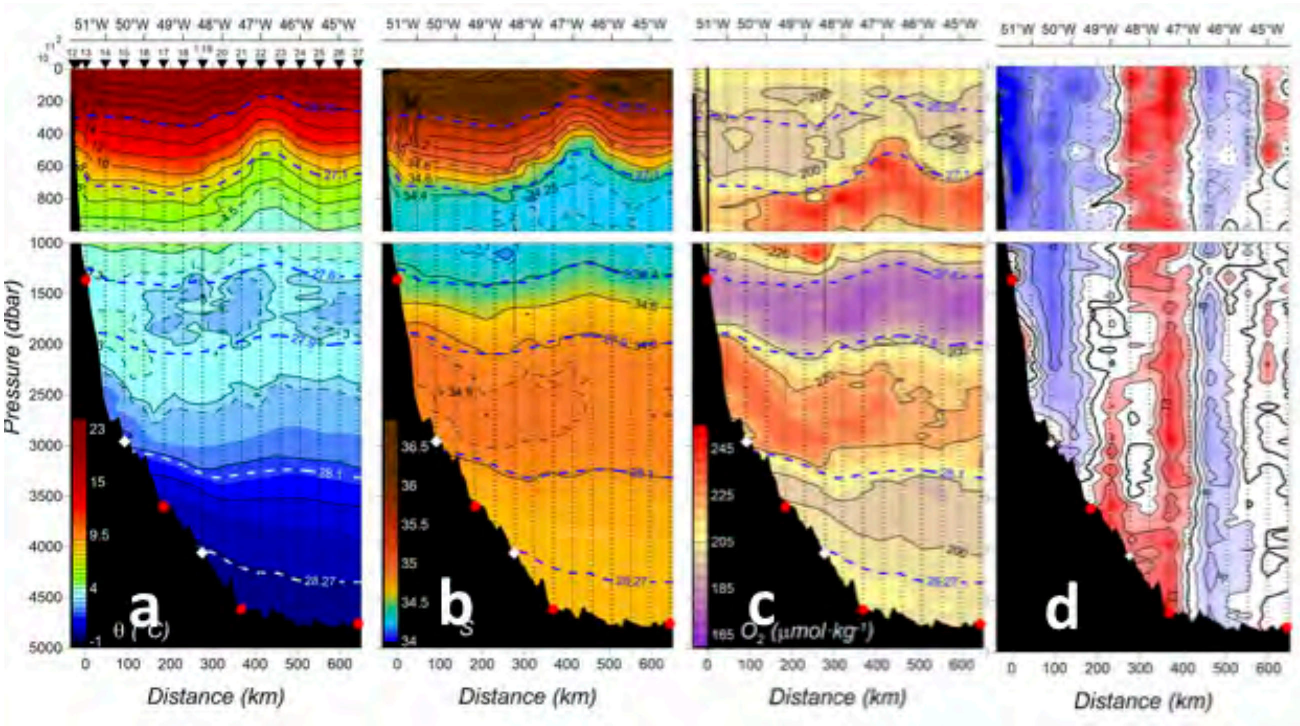


Fig. 19: Vertical sections of Temperature (a), Salinity (b), Oxygen (c) and along-shore velocity across SAMBA, from the shelf-break to site D.

5.2 Hull mounted ADCP (D. Valla and H. Fenco)

Data Acquisition: VmDas

Two TRDI vessel-mounted Acoustic Doppler Current Profilers (VMADCP) where available for use during the SAM15/SAMBAR01, an Ocean Surveyor 75 kHz (OS75, S/N 186) and an Ocean Surveyor 150 kHz (OS150, S/N 1867). The former was run in narrowband mode while the latter was used in broadband mode, which translates into an upper and lower reference limits of 150-300 m and 75-150 m, respectively. Each VMADCP were controlled by two separate deck units located in the main lab (Figure 20). The bin size for the OS150 was set to 8 m, the number of bins to 45 and the blanking distance 6 m. For the OS75, the bin size was set to 45 bins with a bin depth of 16 m and a blanking distance at the surface of 8 m. The time between pings was set to 2 seconds before deployment to 2 seconds.

Figure 20. Deck unit controlling each VMADCP located in the main lab.

Settings and configuration

The ADCPs were controlled via VmDas v.1.49 installed on a single PC with 1GB of RAM located in the main lab. The PC had to be formatted and a new OS Windows 7 32-bit available on board was installed to replace an older OS Windows XP 32-bit during our transit to the work area. Because this older OS system was deactivated, the PC was unusable. It was not possible to install the new OS via the USB CD-ROM available in the lab, therefore, a bootable flash drive containing an image of the Windows 7 OS to be installed was employed. This bootable flash drive was also used to access the PC hard drive and back up the data stored there.

The TRDI VmDas software was used to store the data collected by the VMADCPs. Next we provide some quick-look notes for setting up the software:

Open VmDas, click on File - Collect data. Then in Options - Edit data options:

- Communications tab:
  Set up such that under Current Setting the COM Port Setup is set to:
  ADCP Input: COM7, 9600, N, 8, 1
  NMEA1 Input: COM4, 4800, N, 8, 1
  NMEA2 Input: COM3, 4800, N, 8, 1

- ADCP Setup tab:

a) ADCP setup from file: SAM15 OS75 Narrowband NO bottom track NO sync.txt (OS75) and OS150BBDEF.txt (OS150) see Annex 5, time between ping ensembles: 2 seconds.

- Recording tab:
  Name: AI201803 (we used this name convention for all underway collected during the cruse). We added a letter at the end each time the acquisition was stopped and re-started.
  Max size: 5 (MB; when that size is reached, VmDas starts a new file with automatic numbering) no dual output directories.

- Nav tab:
  NMEA Ship Position (GGA) Source: Enable, choose NMEA1 from drop down menu disable.
  NMEA Ship Speed (VTG) Source: Enable, choose NMEA1.

- Transform tab:
  Heading Source: HDT, NMEA Port: NMEA2, Fixed Heading set to 0.
  Tilt Source: ADCP Tilt Sensor, Fixed Pitch=0, Fixed Roll=0 (don't enable tilt correction)
  Heading Sensor Magnetic/Electrical Corrections: 0 EV: Primary Heading Error, 0 EV Backup.
  ADCP Alignment Correction: 60.5 (OS75) and 46.2 (OS150) in the EA Heading alignment error. This values were taken from data collected in previous cruises on board the Alpha Crucis.

- Averaging tab:
  The STA interval was set to 120 seconds, LTA to 600 seconds
  Profile Ping Normalization Reference Layer was enabled and set to start bin = 3, end bin = 10.

Output data format

The naming convention of the output files is as follows: CRUISE_xxx_yyyyyy.END where CRUISE is the name set in the data options recording tab of VmDas (in this case, AI201803), xxx is the number set in the "recording" tab and changed before every restart of recording, and yyyyyy is a number automatically set by VmDas starting from 0 and sequentially increasing when the file size becomes larger than max size. END is the filename extension, denoting the different files that are created for each recording. The following list shows all the different file types that were created during the navigation and their content.

- ENR: binary; raw ADCP data file.
- STA: binary; average ADCP data, using the short time period specified in VmDas Data Options.
- LTA: binary; average ADCP data, using the long time period specified in VmDas Data Options (see Figure 21).
- ENS: binary; ADCP data after screening for RSSI and correlation, either by VmDas or adjusted by user, and navigation data from .NMS file.
- ENX: binary; ADCP single-ping data and navigation data, after having been bin-mapped, transformed to Earth coordinates and screened for error velocity, vertical velocity and false targets.
- N1R: ASCII text; raw NMEA data.
- N2R: ASCII text; raw NMEA data.
- NMS: binary; navigation data after screening and pre-averaging.
- VMO: ASCII text; option setting used for collection the data.
- LOG: ASCII text; all logging output and error messages.

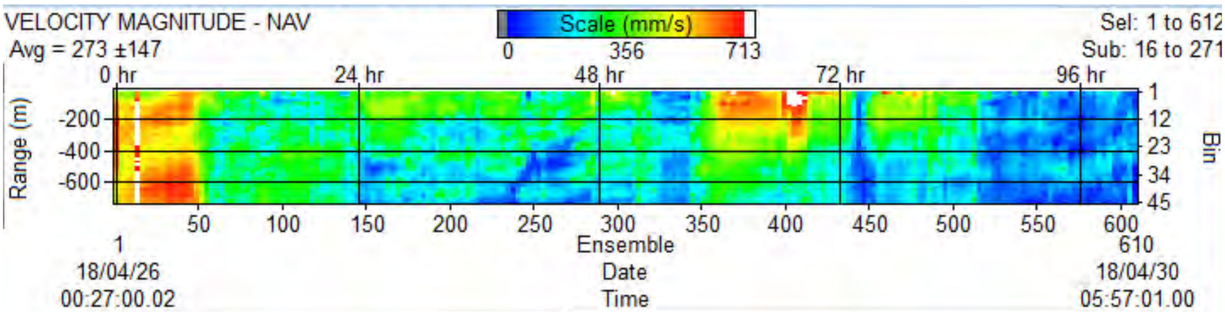


Figure 21. Visualization for an LTA output file as displayed by WinADCP. The "velocity magnitude" parameter is shown.

After the completion of the cruise, a stick vector plot of the velocity along the ship's track is displayed in Figure 22. Fig. 23 shows preliminary vertical profiles of u and v from the VMADCP data collected with the OS75 along the Albardão/SAMBA-W transects.

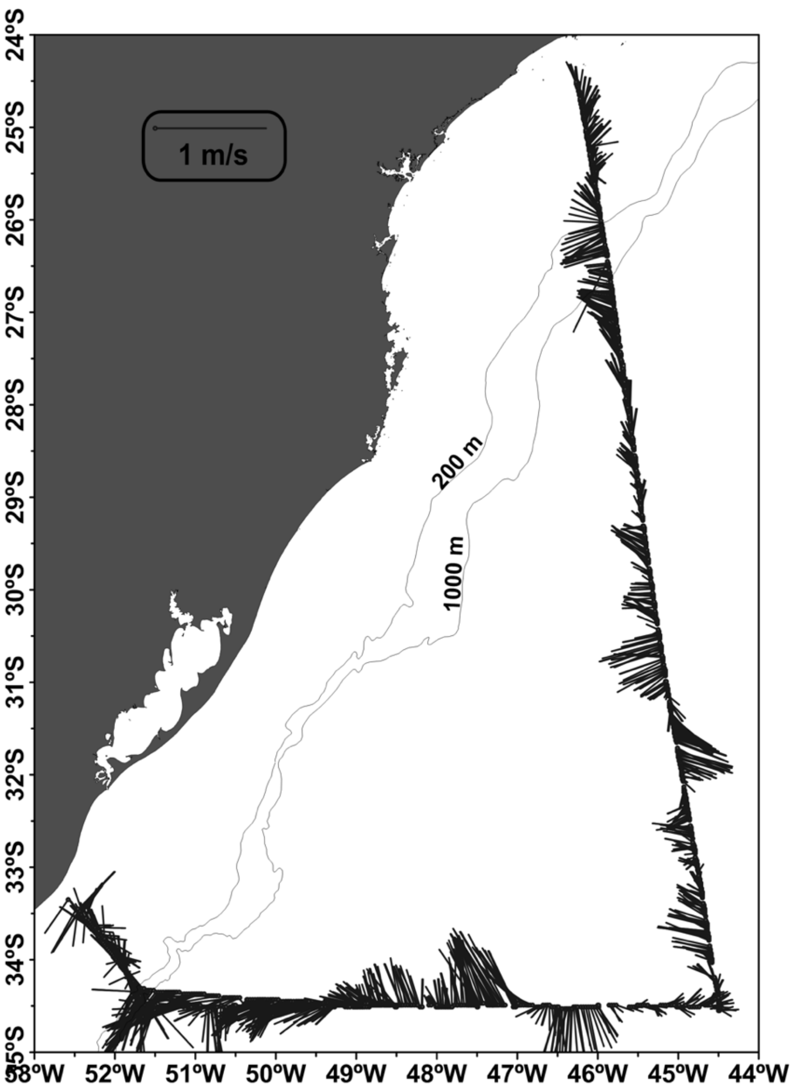


Figure 22. Surface currents derived from the VMADCP OS75 collected during the cruise.

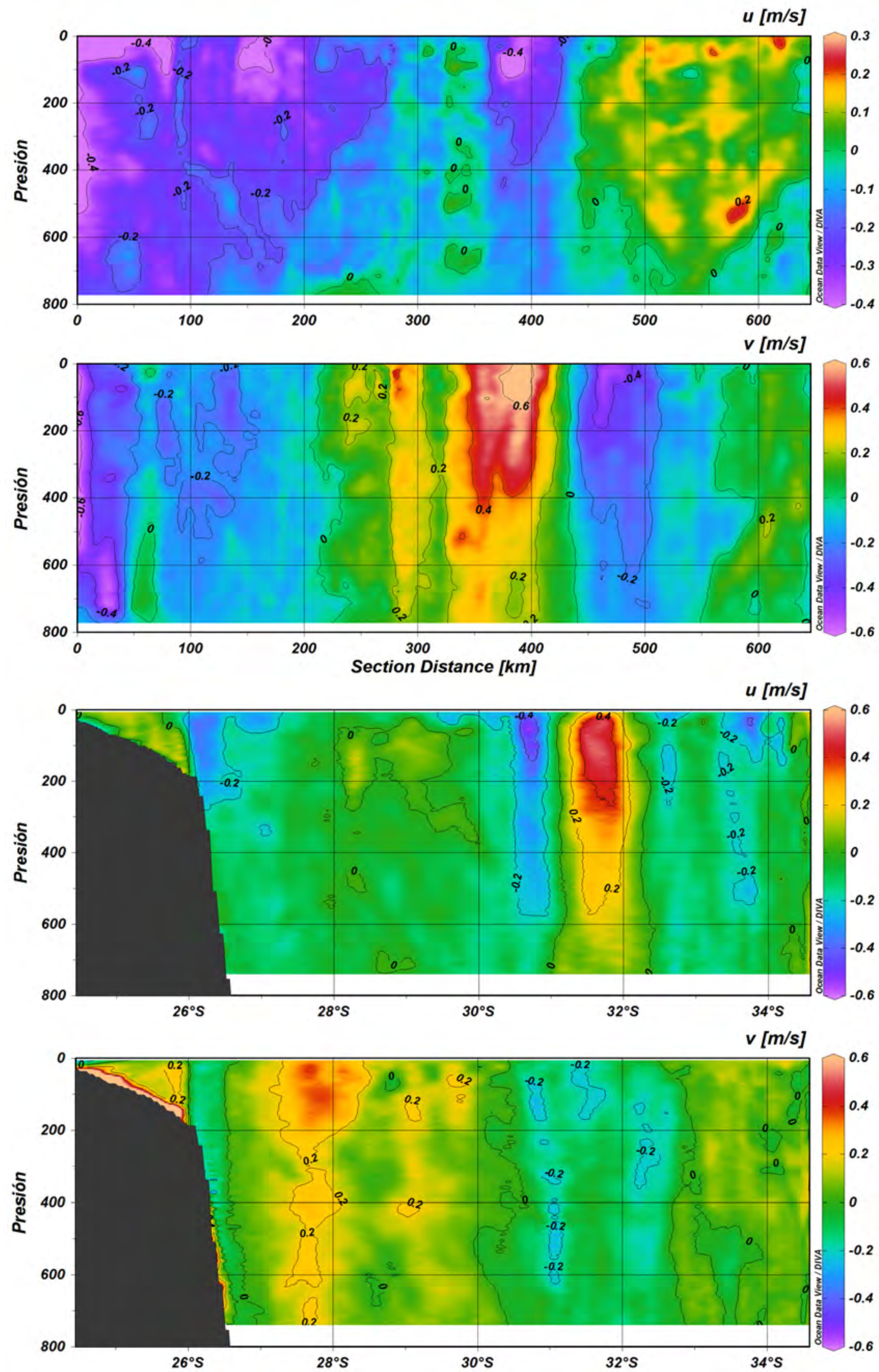


Fig. 23 Vertical sections of velocity from the ship's mounted ADCP. Top two: U and V along SAMBA. Bottom two: U and V across the AX-SAMBA section.

5.3 CTD and water samples observations (R. Guerrero & M. Charo)

27 CTD stations were performed and 48 XBT profiles (figure 3 and Table VI and VII). CTD stations were performed with a SBE911 rosette package. A SBE-32 carrousel with 24-5lts OceanTest Equipment-Niskin bottles was used for water sampling. The CTD was equipped with redundant TC & Ox sensors, a turbidimeter/fluorometer, a self contained L-ADCP and an altimeter for approaching the bottom (Table X), for sensor details see Figures 5 and 14. The CTD/Rosette package was assembled the day before departure and installed fresh calibrated TC & Ox primary and secondary sensors (Table X).

Table X: CTD, ADCP and TSG (termosalinograph) sensors used on the cruise.

System	Sensors	Model	Serial N	Calibration date
CTD	Pressure Digiquartz	SBE 9plus	1112	12-Sep-2012
Primary	Temperature Conductivity Oxygen Pump 0	SBE 3 plus SBE 4c SBE 43 SBE 5T	5606 4098 2414	15-Feb-2018 30-Jan-2018 06-Feb-2018
Secundary	Temperature Conductivity Oxygen Pump	SBE 3plus SBE 4C SBE 43 SBE 5T	5628 4096 2416	13-Feb-2018 26-Jan-2018 22-Feb-2018
Auxiliary	Flu-Turb. WetLabs Altimeter	Eco AFL/FL Benthos PSA 916	2645 57419	18-Apr-2012 19-Sep-2012
ADCP	RDI-Teledyne	WHS300 KHz	13985	
TSG	Temp-Conduct. Remote Temp.	SBE 45 microTSG SBE 38	0369 64306	

The CTD package was ballasted with 80 kg of lead to balance the L-ADCP on the cage and add weight to the package to reduce kinking on the cable under heavy seas condition. Rosette bottles were tested on deck during the transit to the study area. O'ring set on bottle 14 was change as it showed a leakage during the test. Wilson Natal re-assembled the *end termination* of the 8mm CTD *Electro-Mechanical* cable. It was used a steel block with a *wood alloy* for traction and a water tie electrical connection for communication and data telemetry. This electro-mechanical termination operated thru the extension of the cruise. For security a *Chinese finger* was also installed above the block with a loose heavy rope attached to the cage.

Station 1 was a test profile performed down to 1848 db on site BB (4140m). Bottles positions 1 to 5 were triggered at this depth to collect high salinity (old upper circumpolar deep water) to be used as sub-standard during the salinity measurements on the Autosal bench salinometer. Bottles 6 to 24 were distributed thru the water column to collect geochemical samples.

Stations 1 to 10 were taken on the continental shelf (20 to 160m), 11 to 14 at the shelf break and slope (400 to 2538m) and stations 15 to 27 were deep open sea stations (2876 to 4764m). The CTD package, ones in the water, was lowered immediately to 10 m for sensor soaking and pump activation. When this condition was obtained, the CTD was rise to the surface and marked the acquisition to latter extract the surface and scan number records. Immediately after, the CTD was lowered at 30 m/min down to 100 / 150m, then 45 m/min down to 200/250m and finally 60 m/min up to 100 m off the bottom. A benthos altimeter was used to control the approach to the bottom with an alarm programed on SEASAVE to ring 10m off the bottom. Depending on winch maneuvering and sea conditions the CTD package was lowered up to a safe distance of 10 to 20 meters off the bottom for the deep, shelf break and slope stations, and 2 to 5 meters on the shelf stations. From 100 m off the bottom the lowering speed was reduced to 30 m/min and to 20 m/min around 40 m when the altimeter start to reflect the distance to the bottom. The upcast was started at 45 m/min (after tripping of bottom bottles) and immediately after increased to 60m/min to near the surface. In the way up, the package was stopped at selected depth to close bottles for salinity and geochemical analysis. Trigger release mechanism of position 8 failed on station 1. Same failure of the trigger mechanism occurred for position 9 on stations 24, 25 and 26. Tripping of the rosette position on deck was successful. The whole triggering system was serviced in our way back to Santos port.

On shelf station 6, 7 & 8, with a stratified water column, the oxygen and salinity profiles (primary and secondary) showed loops and spikes. After station 8, the pumps from both plumbing systems were check for malfunctioning, but showed normal operation. Afterward the L-ADCP position in the cage, located originally in front of the SBE9 TC sensors (Fig. 14a) was changed to the left flank of the CTD (Fig 14c). The loops and spiking on these parameters diminished significantly for the following stations. It is believed that loops and spiking is the result of a combined effect of low lowering speed (15 to 30 m/min) on this stations, the waving action due to rolling of the ship and the closeness of the L-ADCP to the TC duck sensors intake.

In some stations following CTD 8, there was a delay in the start of the pump. On a SBE 9, the pump turn-on when raw conductivity frequency exceeds 3500 Hz, equivalent to 0.5 units in salinity and a subsequent 60 seconds delay time has elapsed. These started to occur after the plumbing re-assembly when the pumps were tested. No obvious misalignment was observed in the primary plumbing and when this problem occurred, it was solved moving the package up and down during the soaking period. Bottom landing of the package occurred on station 12 (760m). This happened while approaching the bottom, at very low speed (< 15 m/min), and the winch operator didn't listen the stop command from the console operator. The cage laid on the bottom for 2 seconds. The only symptom observed in the data was a small spike in the salinity profile for 1 second.

1771 water samples were collected at selected depths from the rosette bottles (fig. 5) in order to collect salinity and geochemical samples. Table XI shows the number of samples taken for each parameter on the 27 CTD/rosettes casts.

Table XI: Number of water samples taken from the rosette for the different physical and geo-chemical parameter.

ST #	O_2	ALK (UERJ)	ALK (FURG)	pH	DIC	SAL.	NUT.	CHL-*a*	SPM	Micro-Bio.
1	13			13		16	13	3	3	
2						2				X
3	3	2	1	3	4	2	3	3	3	X
4	3	2	1	3	4	3	3	3	3	
5	3	2	1	3	4	2	3	3	3	
6	4	-	2	4	-	4	4	4	3	
7	3	2	1	3	4	3	3	3	3	X
8	3	2	2	3	4	3	3	3	3	
9	5	2	2	5	4	3	5	5	5	
10	6	-	2	6	-	-	6	6	6	
11	5	-	4	5	-	4	5	3	3	X
12	-	2	5	8	4	5	-	-	-	
13	11	2	7	11	4	6	11	2	2	
14	18	2	8	18	4	15	18	5	5	X
15	21	-	8	21	-	14	21	6	6	
16	22	2	7	21	4	19	22	4	4	
17	19	-	8	19	-	10	19	4	4	
18	20	2	8	22	4	15	20	3	3	
19	21	-	8	22	-	18	21	4	4	
20	21	2	7	21	4	15	21	4	4	
21	23	-	7	23	-	17	23	4	4	
22	22	2	7	22	2	16	22	4	4	
23	24	-	8	23	-	20	24	4	4	X
24	21	2	8	21	2	16	21	5	5	
25	23	-	8	23	-	20	23	3	3	
26	21	2	12	23	2	18	21	3	3	
27	22	2	12	23	2	17	22	4	4	X

5.4 Data acquisition and preliminary post-processing (M.Charo)

Data acquisition, via the SBE11 deck-unit, was done using SEASAVE V7.22 software. CTD data were preliminary post-processed according to common standards, using Seabird Data Processing V.7.26.7 software routines (Seasoft-Win32, http://www.seabird.com/software/software, SBE, 2017). The nominal calibrations were used for data acquisition.

Typical Data Processing Sequences

- Data Conversion: Convert raw .hex to engineering units, and store converted data in *.cnv file (all data) and/or *.ros file (water bottle data).
- Wild edit: Mark data value with *badflag* to eliminate wild points.

- Filter: Low-pass filter columns of data.
- Align CTD: Align data (typically conductivity, temperature, oxygen) relative to pressure. This ensures that calculations of parameters are made using measurements from same parcel of water.
- Cell Thermal Mass: Perform conductivity cell thermal mass correction if salinity accuracy of better than 0.01 PSU is desired in regions with steep gradients.
- Loop Edit: Mark scans where CTD is moving less than minimum velocity or traveling backwards due to ship roll.
- Derive: Calculate salinity, density, oxygen and other parameters.
- Bin Average: Average data into desired pressure or depth bins.
- Bottle Summary: Summarize data from water sampler *.ros file, storing results in *.btl file.

CTD Data are reported in standard Seabird Converted Data File (cnv) format. Converted files consist of a descriptive header followed by data converted to engineering units. The header contains station time and position information; the name of the raw input data file; the number of data rows and columns; a description of observed and derived variables in each column; interval between rows; scan rate or bin size and records of all processing steps.

5.5 Salinities measurement (R. Guerrero, J. Manuel Barbosa & Luciana Kfouri)

Figure 5.3.1: Autosal Guildline 8400B bench salinometer used for on board salinity analysis.

A total of 266 salinity samples were taken and analyzed aboard the ship during the cruise in order to monitor CTD conductivity sensor performance and bottle closure depth. These samples were processed with a Guildline 8400b Autosal (SN71012)(Figures 4 and 24), using IAPSO *P160*; k15: *0.99983,* Sa: *34.993*; Exp.date: *June 2019.* The salinometer bath temperature was set to 24˚C and the room temperature was kept between 0.5 and 2˚C below the setting temperature. The room temperature was measured with a digital platinum thermometer with 0.1 °C resolution.

Luciana Kfouri, Juán Manuel Barbosa y Raúl Guerrero ran the samples and the calibration for each of the 8 runs. At the start of each run, the standardization was performed using new IAPSO standard seawater bottle from batch P160 (June 2019 expiration date). Autosal calibration was performed following the manual of the instrument, starting with a bath temperature control check, and then followed by the reference calibration as well as the zero calibration. Before starting the standardization, we flushed the cell about 6 times with a Sub-Standard bottle taken at Station 1 to clean the cell from DI water standing in the system since the previous run and to have a pre-reading of a known value prior to calibration. Once the cell was rinsed with salty water, a new standard seawater bottle was introduced. The cell was then flushed 3 times before each of at least 3 readings. Once the readings were stable, the Autosal was standardized, entering the value of the conductivity ratio and the batch number of the standard seawater.

The Autosal data were recorded using the Salinometer Data Logger software, from Ocean Scientific International (SDL-OSIL). Salinity was calculated according to the Practical Salinity Scale of 1978 (UNESCO 1981). In order to test the stability of the Autosal readings, duplicates were taken from 4 bottom bottles (2197 db) on Station 1. These duplicates were used as sub-standards for the Portasal. On each run, one sub-standard was used at the opening of the run (after Vial calibration), at mid-run (eventually) and at the end, as there was a limited number of new vials, to close the run. This procedure allowed to follow the stability of the Autosal. On the first run and calibration procedure the instrument didn't required standardization. It stays calibrated since the last time used in September 2016. Thru the 8 runs it wasn't even necessary to use the standardize knob. On every new standard water opened, the conductivity ratio reading from the Autosal was just the vial Rc value of 0.99983, showing optimal stability throughout the cruise.

5.6 Performance of the CTD salinity and Oxygen (M. Charo & R. Guerrero)

CTD Salinity

The accuracy of the salinities measured by the CTD was evaluated by comparing the salinities from the water samples with the primary and secondary salinity values coming from the CTD (DeltaS0 and DeltaS1).

A total of 266 salinity bottles were drawn from the rosette bottles. After taking out outliers outside a mean plus-minus 2 time the standard deviation in three iterations, the number of sample used to preliminary estimate the error and uncertainty on the CTD salinities was 225 observations for primary and 226 for secondary sensor. Figure 25 shows the deltas (BTLsal – CTDsal) versus depth for both primary and secondary sensors. It is also shown a constant fit for primary deltas.

Delta salinity statistics on the salinity differences, for primary and secondary sensors, are presented in Table XII.

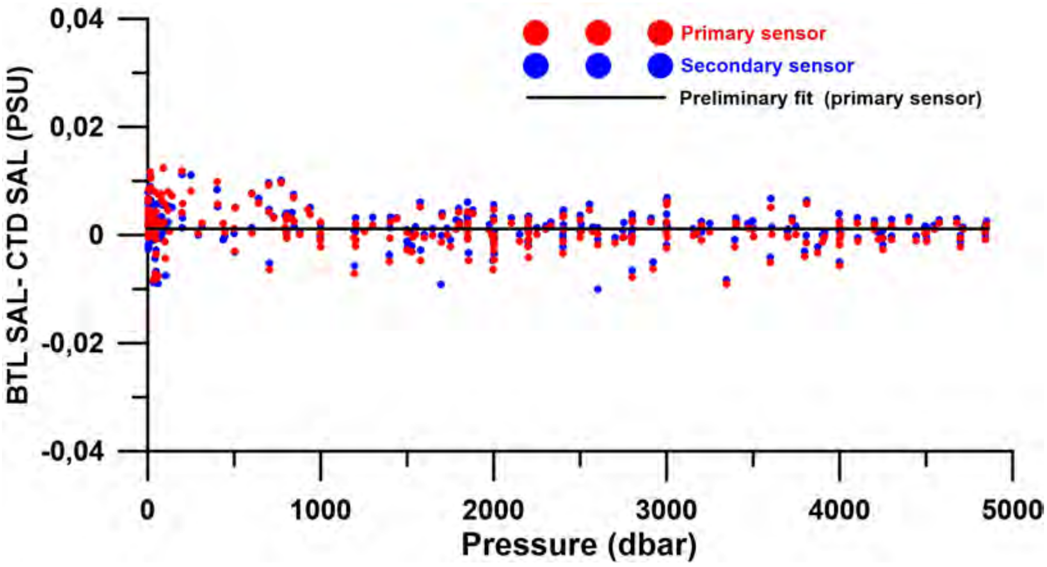


Figure 25: Differences between rosette salinities (BTLsal) and CTD salinities (CTDsal) versus pressure. Red (blue) dots show differences for primary (secondary) sensor. A bias fit for primary sensor is shown.

Table XII: Statistics of the differences in salinity between bottles and CTD for primary and secondary sensors.

Deltas(BTL-CTD)	Mean	StdDev	N obsevations	% used over total
Primary	0.0011	0.0037	225	87
Secondary	0.0015	0.0035	226	87

CTD Dissolved Oxygen

Preliminary calibration of the oxygen sensors (SBE43) was performed using a statistical method estimating calibration coefficient for calculating dissolved oxygen in milliliters per liter (ml l^{-1}) from SBE 43 output voltage. The technique requires dissolved oxygen concentrations reported in ml/l determined from a range of Winkler titrated water samples and SBE 43 oxygen voltage outputs measured at the times the water samples were collected (SBE, 2012).

Mean residual for primary and secondary sensors were 0.001±0.103 (N=361) and 0.002±0.097 (N=361), respectively. Figure 26 presents the differences between SBE 43 dissolved oxygen for both sensors before and after preliminary calibration and Winkler titration dissolved oxygen.

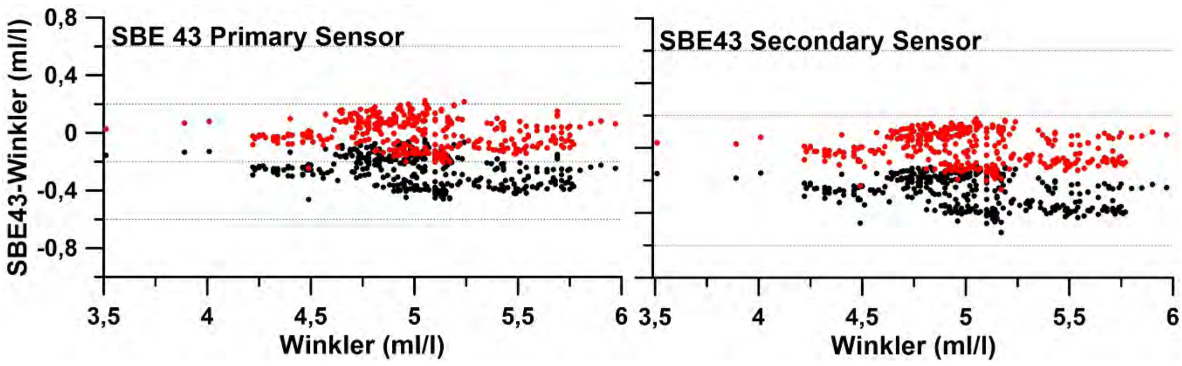


Figure 26. Distribution of dissolved oxygen residuals versus dissolved oxygen concentration (both in ml/l), before (black) and after (red) preliminary SBE43 sensors calibration.

5.7 TSG underway measurements (M. Charo y H. Fenco)

Throughout the cruise, underway quasi-continuous surface temperature and salinity were collected using a SBE 45 MicroTSG Thermosalinograph. The data were recorded at 10-second intervals along track. Temperature sensor SBE 38 is installed 1.5 m from the hull water intake (3m below vessel water line). The thermosalinograph are installed about 2.5 m above the SBE 38 (4 m to the intake). The data from the sensors are transmitted via the SBE45 interface box, where also the NMEA GPS position is collected an string in the data record to the underway PC. On the underway PC a Data Acquisition System gather the TSG data with meteorological and bathymetry information to generate a unique underway data logging.

Thermosalinograph temperature and salinity were compared with CTD temperature and salinity data extracted from the 3 dbar level during down and up casts for each station. The comparison was done based on CTD primary sensors only. Statistics of the differences between the CTD and thermosalinograph are shown in Table XIII and Fig. 27.

Table XIII. CTD versus Thermosalinograph and SBE38 comparison. Number of samples (N) is indicated for each sensor.

Sensors	Mean (CTD-TSG)	Std. Des.	N
SBE38 Temperature (°C)	-0.07	0.03	46
SBE45 Temperature (°C)	-0.44	0.04	47
SBE45 Salinity (PSU)	-0.09	0.01	42

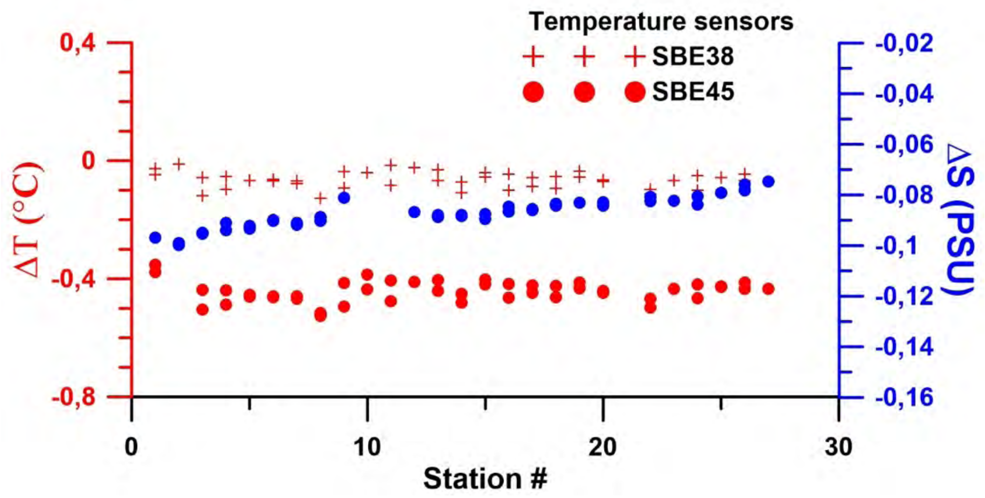


Fig. 27. CTD versus Thermosalinograph and SBE38 comparison for each sensor.

In additional, bottle salinity samples were taken from the thermosalinograph water intake to verify the thermosalinograph calibration along ship track (Fig. 28). Differences between the thermosalinograph salinities and the bottle salinities are shown in Table XIV.

Table XIV. Comparison between Thermosalinograph salinity and water sample salinity.

# SAMPLE	DATE/TIME (UTC)	LATITUDE (°S)	LONGITUDE (°W)	TSG SAL (PSU)	BTL SAL (PSU)	BTL SAL – TSG SAL(PSU)
1	Apr 24 2018 23:09:53	33.7739	52.1859	32.933	32.845	-0.09
2	Apr 27 2018 00:32:10	34.5006	50.1966	36.388	36.301	-0.08
3	Apr 30 2018 15:49:52	34.0580	44.5751	36.020	35.942	-0.08
4	Apr 30 2018 22:25:53	33.2026	44.7215	35.955	35.825	-0.07
5	May 01 2018 01:44:43	32.7782	44.8041	36.466	363845	-0.08
6	May 01 2018 04:47:28	32.3832	44.8833	36.637	3.5597	-0.08
7	May 01 2018 08:09:47	31.9592	44.9624	36.651	6.5815	-0.07

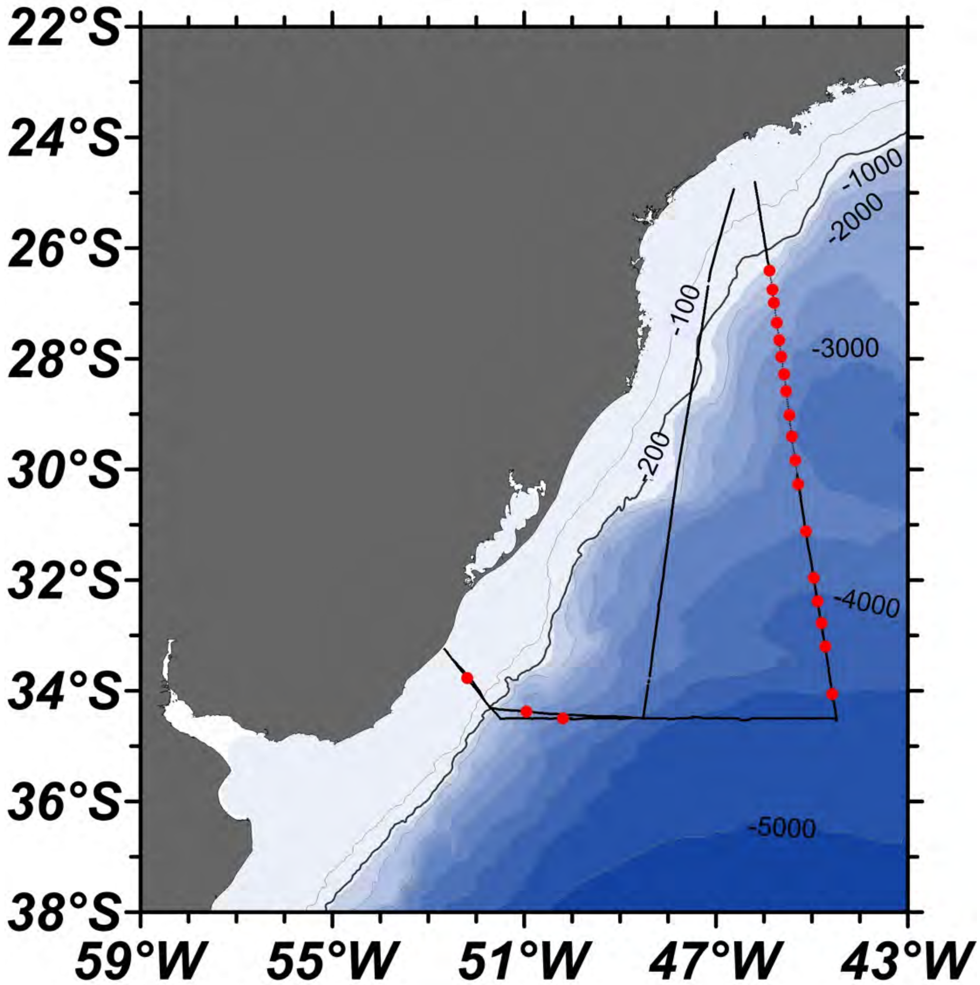


Figure 28: Location of salinity samples (red circle) and cruise tracks along which surface observations were collected (black cross). The background shading and contours indicate bottom topography in meters.

References

- UNESCO (1981). UNESCO technical papers in Marine Science # 39, Vol 3. Paris, France.

- Sea-Bird Electronics Inc: Application Note NO.64-2. SBE 43 Dissolved Oxygen Sensor Calibration and Data Corrections, 13431 NE 20th Street Bellevue, WA 98005, USA, 2012.

5.8 Bathymetry information (G. Manta)

Bottom depth was measured troughout the cruise with an EA600 ecosounder at 12 KHz. The ping rate was set to maximum, and a one-minute average was saved in the Data Adquision System (SAD). The SAD depth data shows a systematic positive offset of 3 m relative to the EA600 depth displayed on the screen on deep water. This offset changed to 1m at waters shallower than 50 m. Bottom detector scale was changed along the cruise following changes in bathymetry. The EA600 was switched from active to passive mode every time there was a PIES/C-PIES communication. Unfortunately, After site ''A'', the EA600 was left in passive mode for several hours while crossing the slope.

The bathymetry form SAM12 and SAM15 sections was procesed in order to get a filtered bathymetry of the transect (Figure 29; see methods below). The result is available with the name ''SAM_12_and_15_bathymetry''with an extension .mat and .txt.

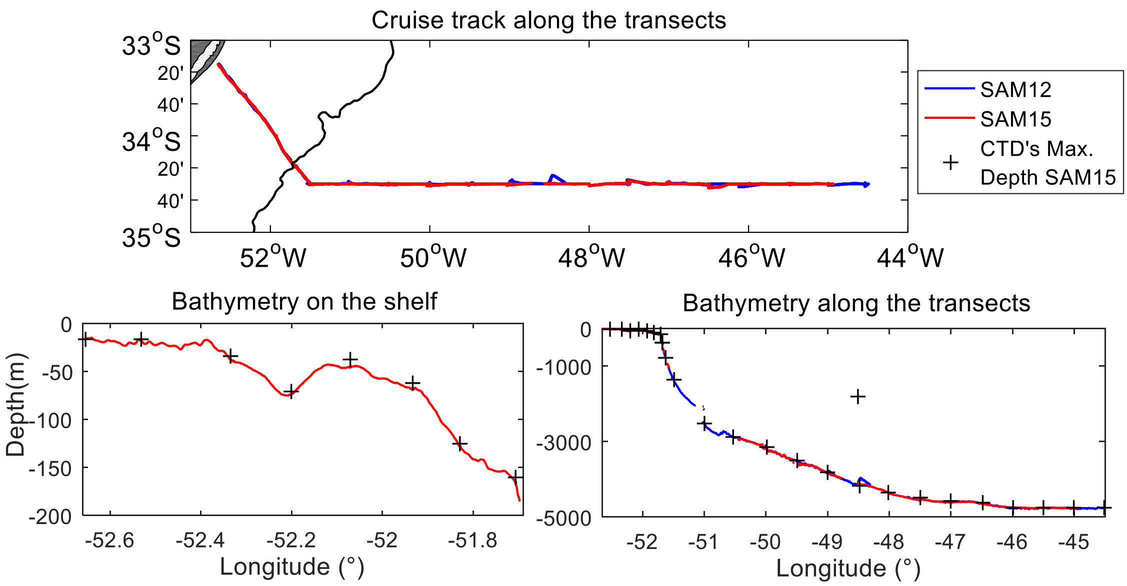


Figure 29. Up: Cruise track from cruises SAM12 and SAM15 along the Albardao and SAMOC sections. The black line shows the 200meters isobath. Down left: Filtered bathymetry measured by the ecosounder E600 on the shelf during SAM15. Down right: Filtered bathymetry measured by the ecosounder E600 on SAM15 (red) and SAM12 (blue). Plus symbols show the maximum depth measured on each CTD profile in SAM15.

<u>Method used for filtering the bathymetry records</u>

Values of 0, 3.1 and 3.0 depth, asociated with''wrong data'', were flagged as Not a Number (NaN). In order to remove ''spikes'', a centered moving average of 200 timesteps (200 min) ignoring NaNs was calculated. Then, a depth-anomaly was calculated with respect to the smoothed depth and all those values above or below one standard deviation were classified as spikes and removed from the original depth. With the spikes and wrong data removed from the original depth, a second centered moving average of 10 timesteps (10 min) was calculated and used as the final filtered bathymetry.

Table XV below shows the depth records from different instruments along the CTD stations. 12.09 and 8.27 meters were the mean and median of the altimeter measurement respectively in the near bottom depth. When substracting the maximum depth registered by the CTD plus the altimeter value to the registered depth by the ecosounder EA600, several negative values were observed, which means that the ecosounder was measuring shallower than CTD. Therefore, there are still some uncertainties in the accuracy of this records that should be analyzed in order to validate EA600 data by comparison with other independent sources beside the CTD plus altimeter information shown here.

Table XV: Depth records from different instruments in meters at the different CTD stations. The ecosounder (EA600) depth corresponds to values at the beginning of the station derived from SAD. The altimeter measurement is the minimum record in the last 3 meters of maximum depth. E600- (CTD+A) is the subtraction of the maximum depth registered by the CTD plus the altimeter value to the depth registered by the ecosounder.

CTD Station	Depth E600 at SAD (m)	Depth Max CTD (m)	Altimeter (m)	E600 - (CTD+A) (m)
1	4176	1830	-	-
2	397	399	6	-8
3	15	16	1	-2
4	18	16	2	0
5	37	34	4	-1
6	74	70	5	-1
7	45	38	8	-1
8	68	63	7	-1
9	128	126	3	-1
10	165	160	8	-3
11	399	391	8	1
12	758	762	2	-6
13	1360	1341	8	11
14	2536	2519	8	8
15	2876	2870	10	-4
16	3148	3128	11	9
17	3503	3488	8	6
18	3832	3811	11	10
19	4162	4154	8	0
20	4357	4366	7	-15
21	4553	4471	34	48
22	4603	4595	9	-1
23	4643	4630	12	1
24	4744	4743	9	-8
25	4758	4754	10	-7
26	4764	4759	14	-9
27	4757	4751	12	-6

5.9 XBTs (F. Oliveira & E. Campos)

The SAMBA-West XBT line

Starting after Station 7, one XBT was launched in between pairs of adjacent stations of the SAMBA line. Until site D, the total of 18 probes were deployed: 4 (four) Deep Blue model in the regions shallower than 700 meters, and 14 T-5 for the deeper regions. Details of each launch are given in Table VII and Figure 30 displays the vertical temperature section produced with the data collected by the XBTs along SAMBA.

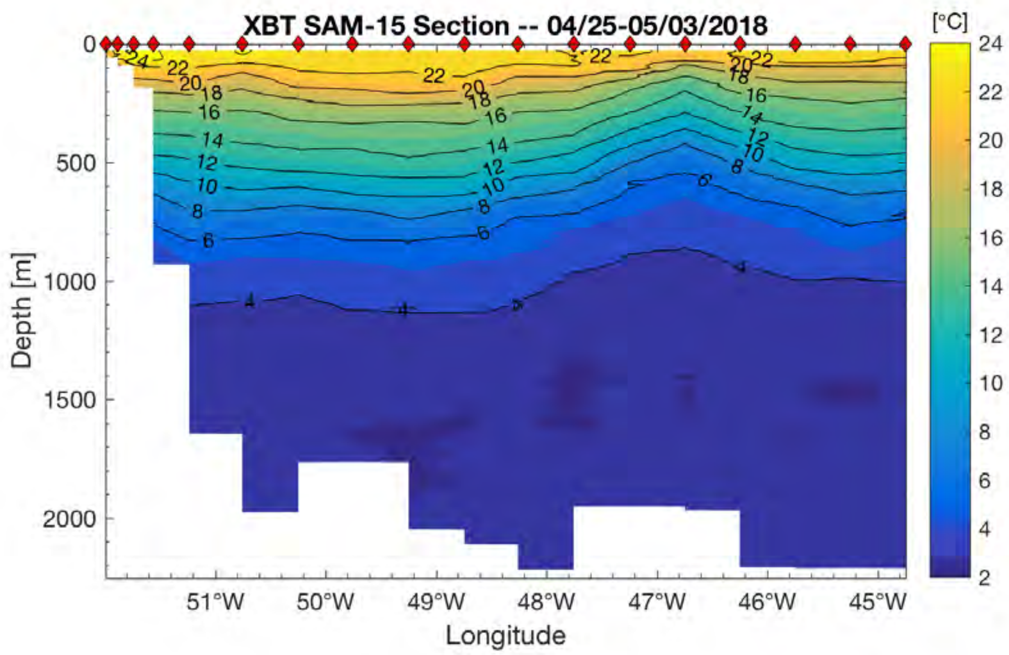


Fig. 30: Vertical temperature section from the XBT data along SAMBA. It shows clearly the presence of a cyclonic eddy centered approximately at 46.5° W. This Eddy, strongly barotropic, was also captured by the CTD and LADCP casts.

The "AX-SAMBA"

Deployment of T-5 and Deep Blue probes were done in 28 locations along the ship's track on the way back to Santos, between latitudes 34.08°S and 24.59°S (Fig. 13). The location and details of these XBTs are summarized on Table XVI. During the almost four days of transit, 20 T5 and 8 Deep Blue instruments from the deep ocean to the continental shelf region, reaching maximum depths from approximately 41 to 2252 meters. Figure 31 shows the temperature section sampled by the XBTs along the AX-SAMBA.

Table XVI: Details of each XBT launching along the "AX-SAMBA", from Site D to Santos

Station #	Date	Hour	Longitude (°W)	Latitude (°S)	Max. depth (m)	XBT Type
19	04/30/2018	15:25	44.57	34.08	2207	T-5
20	04/30/2018	18:49	44.64	33.66	2229	T-5
21	04/30/2018	22:04	44.71	33.24	2231	T-5
22	05/01/2018	01:29	44.8	32.80	681	Deep Blue
23	05/01/2018	04:23	44.88	32.41	1347	T-5

24	05/01/2018	07:59	44.96	31.98	2232	T-5
25	05/01/2018	11:15	45.04	31.55	1854	T-5
26	05/01/2018	14:29	45.13	31.14	2055	T-5
27	05/01/2018	17:38	45.2	30.71	2208	T-5
28	05/01/2018	20:41	45.27	30.29	2252	T-5
29	05/01/2018	23:45	45.35	29.87	2054	T-5
30	05/02/2018	02:39	45.41	29.44	2134	T-5
31	05/02/2018	05:32	45.47	29.03	2210	T-5
32	05/02/2018	08:29	45.53	28.60	2228	T-5
33	05/02/2018	10:40	45.58	28.29	2229	T-5
34	05/02/2018	12:50	45.64	27.98	2227	T-5
35	05/02/2018	14:52	45.68	27.67	2217	T-5
36	05/02/2018	17:02	45.73	27.37	2142	T-5
37	05/02/2018	19:07	45.78	27.05	2025	T-5
38	05/02/2018	20:54	45.81	26.84	1475	T-5
39	05/02/2018	21:33	45.82	26.75	1330	T-5
40	05/02/2018	23:52	45.88	26.45	659	Deep Blue
41	05/03/2018	02:11	45.94	26.13	431	Deep Blue
42	05/03/2018	04:23	45.99	25.84	169	Deep Blue
43	05/03/2018	06:50	46.06	25.51	122	Deep Blue
44	05/03/2018	09:09	46.11	25.20	93	Deep Blue
45	05/03/2018	11:34	46.17	24.90	53	Deep Blue
46	05/03/2018	14:01	46.24	24.59	41	Deep Blue

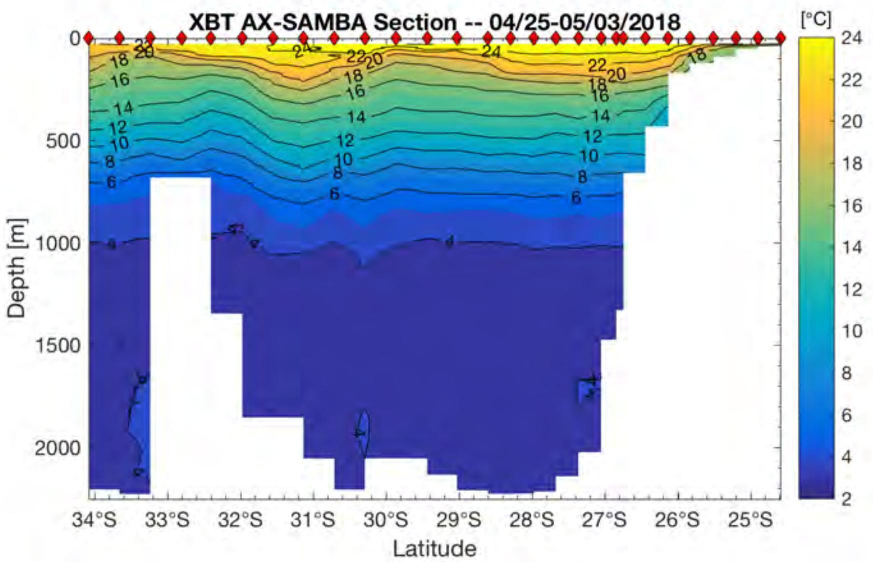


Fig. 31: Temperature section sampled with XBTs along the ship's return track, from site D to Santos.

5.10 PIES/CPIES Operations (P. Pena, R. Garcia & E. Campos)

Three PIES were shipped from the US to Brazil. Two of them to be used for deployments at sites B and D, and one as a spare. Another PIES, already in Brazil, was also brought onboard as a spare.

In general the cruise was successful and all the work was done as planned. In the following pages, the field operations related with the PIES and CPIES are related. This includes the description of the repairs and upgrades performed for some of the IESs during the cruise. Table XVII shows the location of each instruments, considering the reallocations occurred during the cruise.

Table XVII: Location of the Inverted Eco-sounders after the cruise.

Instrument locations							
	Site A	Site AA	Site B	Site BB	Site C	Site CC	Site D
Before	PIES 221	CPIES 289	PIES 244	CPIES 290	PIES 280	-	PIES 187
Current	PIES 221	CPIES 290	PIES 401	CPIES 289	PIES 280	-	PIES 282

Detailed information on the operation performed on each of the units is given in below.

Site A

Operation: Telemetry PIES SN=221
Latitude: 34° 30.290 **S**
Longitude: 51° 29.910 **W**
Depth: 1360 m
Deck units: Brazil (primary) and NOAA

Date: 4/26/2018
Time in station: from 02:30 to 08:30

Notes:

- The ship had to be repositioned twice but no data was lost.
- The instrument began sending data and abruptly stopped after the first block even though it wasn’t the end of the day.
- The telemetry was reinitialized and it curiously began sending data from the beginning of the telemetry record again.
- At this site it was learned that the ship was quiet enough to perform telemetry while holding station and during a CTD.

Site AA

Operation: Recovery CPIES SN=289
Latitude: 34° 29.943 **S**
Longitude: 50° 31.183 **W**
Depth: 2885 m

Operation: Deployment CPIES SN=290
Latitude: 34° 29.974 **S**
Longitude: 50° 30.015 **W**
Depth: 2885 m

Date: 4/26/2018
Time in station: from 19:00 to 23:40

Notes:

- Since this CPIES was for all intents and purposes behaving the form identical to the one recovered at site BB, it was decided to directly recover rather than wait to hear it sampling.
- The same as in site BB (SN290), the CPIES SN289 worked for about one week when, probably, the system battery was depleted due to firmware issue reported by URI.
- CPIES 290 was not upgraded from firmware Version: Sep 26 2016 10:52:41 but the ACS chip was replaced with one sent from URI.

Site B
Operation: Recovery PIES SN=244 (unsuccessful)
Latitude: 34° 30.018 **S**
Longitude: 49° 30.007 **W**
Depth: 3535 m

Operation: Deployment PIES SN=401
Latitude: 34° 30.042 **S**
Longitude: 49° 30.020 **W**
Depth: 3535 m

Date: 4/27/2018
Time in station: from 11:00 to 16:00

Notes:

- Some time was spent attempting to recover PIES 244, trying to hear it sampling and sending clear commands.
- The release command was sent without any sort of response detected. The unit was searched for about one and half hour after the estimated surface time, before the decision to deploy PIES 401.
- The deployment of PIES 401 went all well and after hearing it sampling on the bottom, burst telemetry was performed.

Site BB
Operation: Recovery CPIES SN=290
Latitude: 34° 29.994 **S**
Longitude: 48° 30.515 **W**
Depth: 3535 m

Date: **4/23/2018**
Time in station: from 20:30 to 22:30

Operation: Deployment CPIES SN=289
Latitude: 34° 29.949 **S**
Longitude: 48° 30.042 **W**

Depth: 4156 m

Date: **4/28/2018**
Time in station: from 00:00 to 04:00

Notes:

- Attempt to listen for CPIES 290 to sample was not successful.
- It was decided to recover the instrument and read the data stored on the CF card. Fortunately the ship had an old desktop with a CF card reader that was used to copy the data off of the card. For whatever reason, the card could not be read under Windows 7 and in fact Windows prompted to format the card. After trying several alternatives, it was found that booting the PC with linux allowed to read the CF card.
- The diagnostic showed that the recovered CPIES worked for about one week when, it is assumed, the system battery was depleted due to firmware issue reported by URI.
- CPIES 289 was upgraded from firmware Version: Sep 26 2016 10:52:41 to Version: Apr 25 2018 13:34:05 and the ACS chip was replaced with one sent from URI.

Site C
Operation: Telemetry PIES SN=280
Latitude: 34° 29.593 **S**
Longitude: 47° 29.889 **W**
Depth: 4540 m
Deck units: Brazil (primary) and NOAA

Date: 4/28/2018
Time in station: from 12:00 to 19:00

Notes:

- The ship had to be repositioned on one occasion when the quality of the download began to degrade.
- The clear command was sent during the expected MSB window, without knowing for sure the download had stopped, because it was not detected a two-ping reply. The PIES began transmitting and stopped at the end of the block without sending the clear command again. This is an old bug one is familiar with. The best way to describe this bug is that it hears and stores a transmitted command during the MSB window but does not immediately act on it but instead sends another block of data and then pauses the telemetry. The telemetry was restarted after repositioning the ship and to everyone's delight, it was found that not a single day was lost.

Site D
Operation: Recovery PIES SN=187
Latitude: 34° 30.101 **S**
Longitude: 44° 30.213 **W**

Depth: 4757 m

Operation: Deployment PIES SN=282
Latitude: 34° 30.010 **S**
Longitude: 44° 30.010 **W**
Depth: 4752 m

Date: 4/30/2018
Time in station: from 05:30 to 11:30

Notes:

- Communication with PIES 187 at site D was successful. It even started a telemetry download. Unfortunately, however, it was not possible to hear most of the data being sent. After a careful consideration, it was decided to recover the instrument with the suspicion that it was malfunctioning.
- After recovery it was found that the board had come loose and had rotated in the sphere.
- Looking at the data with the URI data analysis package it was realized that the instrument worked well until (coincidently) the very day telemetry was attempted during the previous SAM cruise (October, 2017). There was a spike in the pressure record that seems to have corrected itself but the tau's became noisy until the day of recovery.
- It was not possible to be sure about what happened but the theory so far is that the instrument leaned over at an extreme angle after the battery pack and board assembly came loose. This could explain the abrupt pressure spike and noisy tau's.
- PIES 282 was deployed but communication with the instrument was at best challenging. It was not possible to successfully get a good range but it was heard it to sample on several occasions. There is something different about this site since communication here has always been difficult.

Preparations/repairs of recovered instruments: CPIES SN=289 and CPIES SN=290

1. Replaced clock battery (NO)
2. Recovered data using CF-card reader (YES – only few days of data recovered)
3. Replaced vacuum port o-ring (YES)
4. Replaced release block (YES)
5. Replaced batteries (Yes)
6. Replaced firmware (CPIES62c160926.APP). Only for SN=290.
7. CPIES SN=289 firmware was not changed.
8. Replaced ACS chip

Repairs and tests at sea

PIES 222

- The rubber stoppers were glued using a contact cement provided by the ship.
- The board brought from Miami was reinserted.

- A line was tied to the transducers penetrator to hold the battery pack in place in the event the rubber stoppers came loose again.

PIES 187

- The rubber stoppers were glued using a contact cement provided by the ship.
- A line was tied to the transducers penetrator to hold the battery pack in place in the event the rubber stoppers came loose again.

PIES 282 (in site D)

- The firmware was upgraded from Version: Sep 26 2016 10:52:41 to Version: Apr 25 2018 13:34:05
- Although this is now technically a CPIES, it should behave as a PIES because the current meter measurements were disabled.
- The ACS chip was replaced with one of the ones URI sent to Edmo.

5.11 Moorings of ADCP & BPR: (E. Campos, F. Vicentini, M. Pereira & W. Natal)

Important component of the cruise was the recovery and redeployment of two instruments moored on the shelf-break, off the Brazil-Uruguay border, near 34.5°S (Table XVIII). The two instruments were moored originally in December/2013, then recovered and redeployed in December/2016. As planned, the recovery happened without any problem, the data read from the internal memory and, after installing new batteries, the instruments were relaunched, as described in Table XVIII.

Table XVIII: Details of the ADCP and BPR moorings, at the shelf-break

Moorings		
Specs.	BPR	ADCP
Model	Sea Bird 26 plus – 600m	Teledyne WHS150-UG6
Serial Number	26P68126-1347	1841
Launching data	25/04/2018	25/04/2018
Launching hour	20:21 h (GMT)	22:05 h (GMT)
Position	34° 17,896' S - 051° 42,401' W	34° 19,065' S - 051° 40,671' W
Depth	167 m	400 m

Before the redeployment, data from both instruments were downloaded and saved for posterior analysis. A quick look, however, showed very high quality datasets, with very small percentage of data with any sort of problem. Figure 32 illustrates the time series of velocity measured by the ADCP at different depths. Fig. 33 shows bottom pressure and temperature measured by both instruments. Fig. 34 depicts vertical sections of u and v components of velocity in the plane z-time.

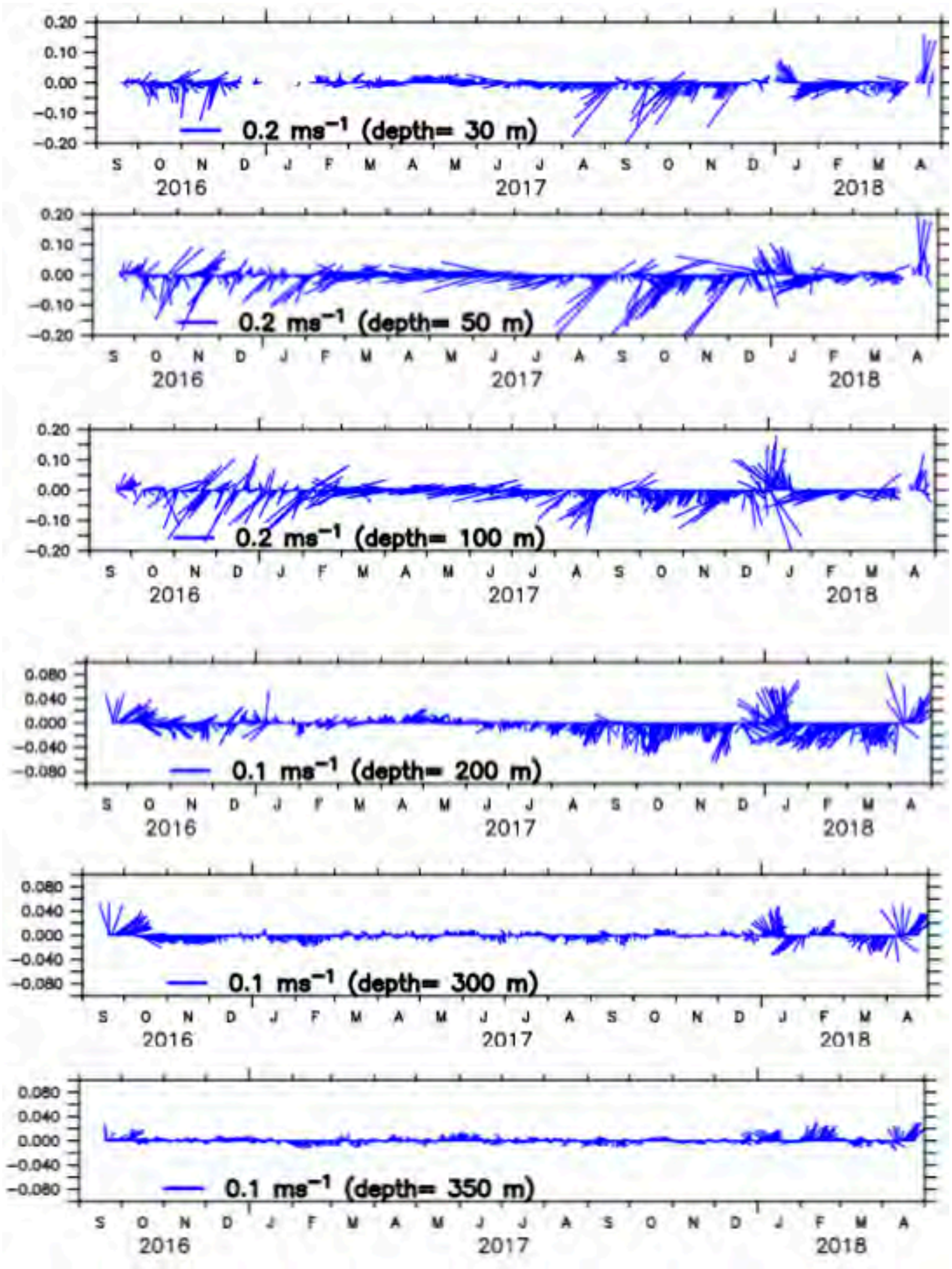


Fig. 32: Stick-plots of the velocity measured by the ADCP at different depths, from 20/Sep/2016 to 24/Apr/2018.

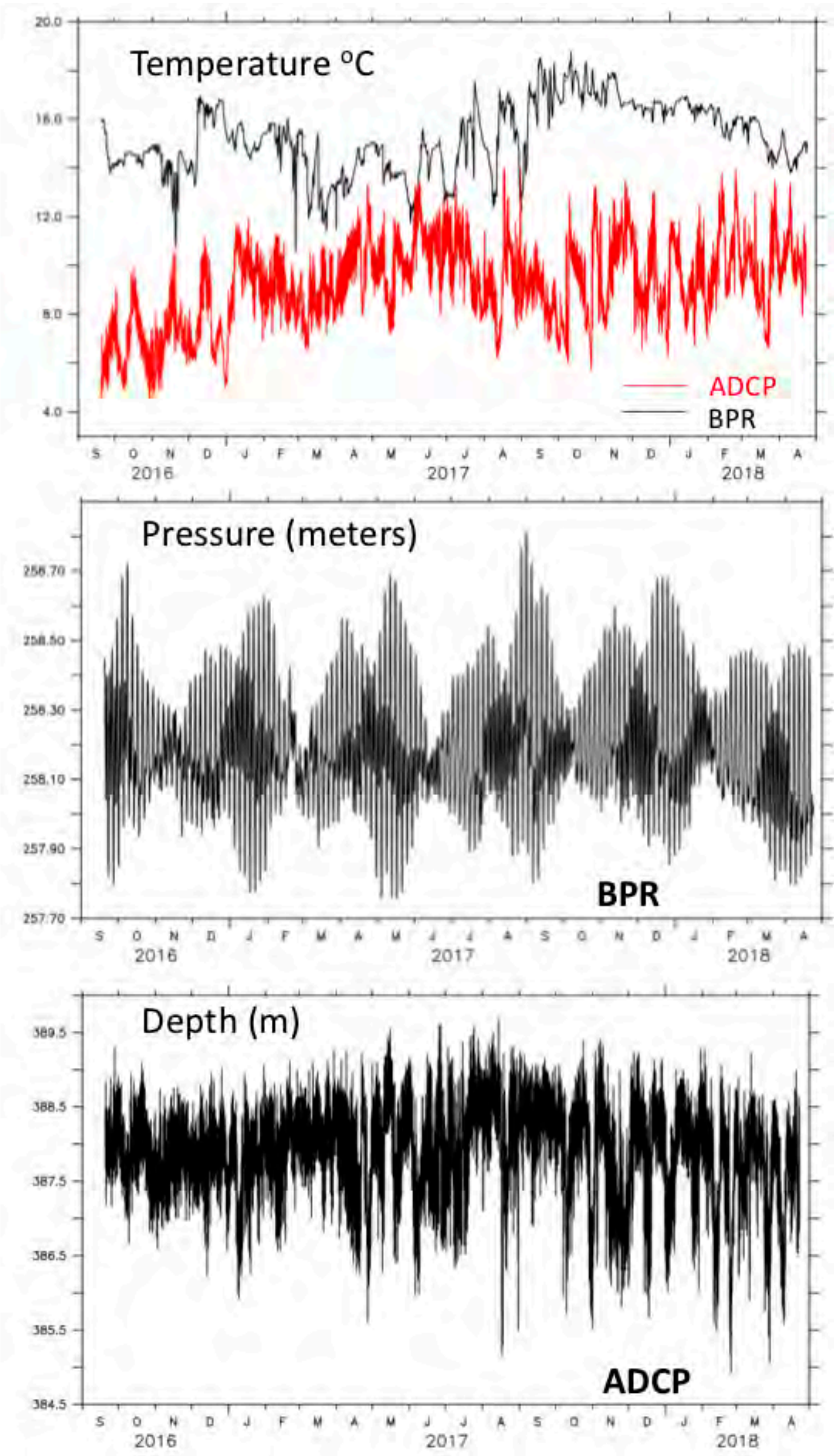
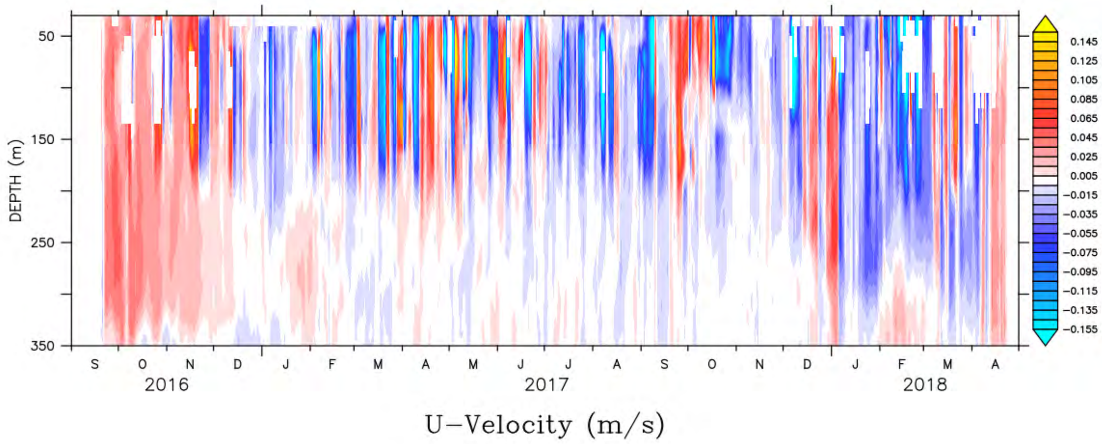


Figure 33: top: Temperature measured by sensors near the bottom by the two moorings (ADCP and BPR). Mid and bottom panels: Pressure and depth, measured by the BPR and ADCP respectively.



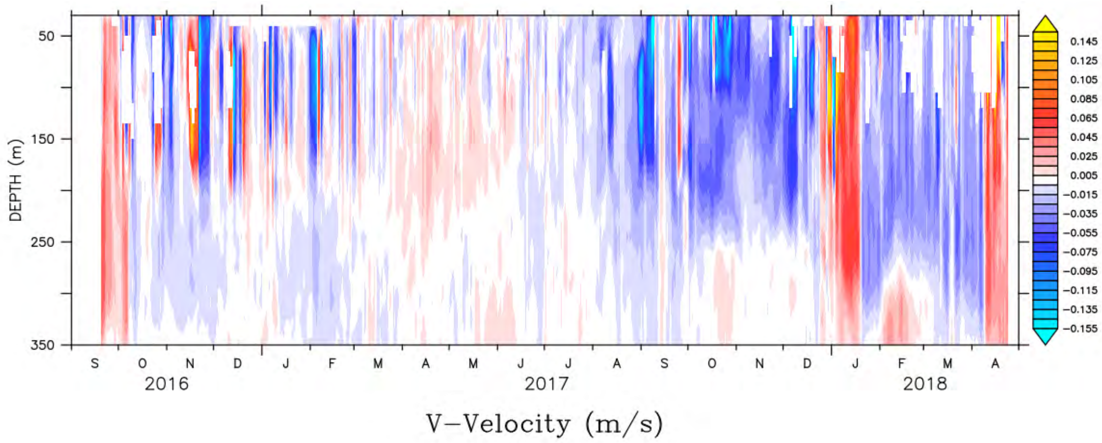
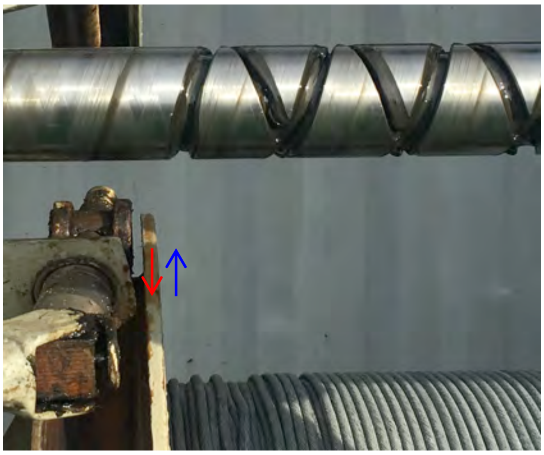


Fig. 34: Depth versus time sections of the zonal (u) and meridional (v) components of the velocity measured by the ADC, between 30 and 350 meters.

5.12 CTD Winch and EM-cable (R. Guerrero)

In 2013, a new 8 mm Electro Mechanical cable was installed on Alpha Crucis hydrographic winch. As the wire diameter changes from the original, the multiplication gears that drive the level wind was rebuild. With this arrangement the spooling onto the drum showed to be smooth at the first wraps (fig. 35a). However, as the succeeding wraps come up, the spooling at both flanges become uneven with back & over of the wire. This problem then propagates inwards with consecutives wraps. It was also observed a valley to the stern flange and a hill on the bow side. Looking into the alignment of the screw groove ends with the flanges of the drums (fig. 35b,c) it was observed a shift toward the bow (see arrows blue and red that do not align). The correction of this shift should improve the spooling on the flanges and in the interior of the drum as the wraps comes.



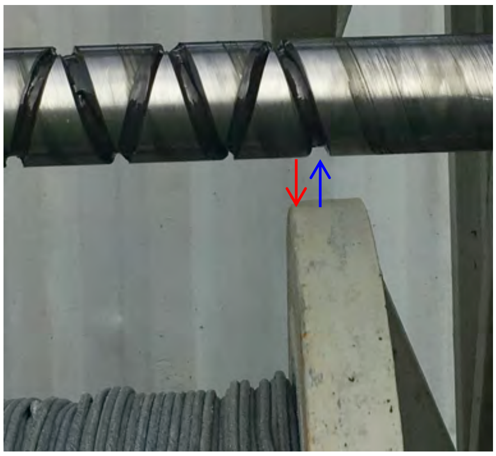


Figure 35: (Top) spooling of the drum showing a smooth of the very first wraps (around 1000 m of cable in). (lower) left and right flange misalignment of the screw groove ends.

5.13 Nutrients, 02, pH and Alkalinity (C. Vieira, J. Mansur, C. Caetano)

The data for water hydro-chemical analysis were collected on board of N/Oc *Alpha Crucis,* between 23 and 30 of April of 2018. A total of 27 stations were realized and, for each station, water samples were collected for the analysis of the following parameters: dissolved oxygen (DO), nutrients (phosphate, silicate, nitrate and nitrite), chlorophyll-a, suspended material, alkalinity, pH and inorganic carbon.

In order to verify the methodologic precision and the quality of the sampling performed by different researchers, in the test station (1) replicates were analyzed for the dissolved oxygen, according to the table XIX.

Table XIX – Data of dissolved oxygen replicates, medium values and standard deviation for the test station (1).

nº of replicates	Depth (m)	Medium value (mL L^{-1})	Standard deviation (mL L^{-1})
5	1848	4,488	0,0096
2	1003	5,410	0,010
3	842	5,690	0,000
2	595	4,690	0,000
3	129	4,647	0,004

The untreated data of dissolved oxygen obtained by CTD at the depths where the bottles were closed and the data obtained by the Winkler method are plotted in the figure 36.

The nutrients, chlorophyll and suspended material samples will be analysed at Laboratório de Nutrientes e Micronutrientes e Traços no Oceano of Instituto Oceanográfico from USP (LABNUT - IO – USP).

The nutrients will be determined by colorimetric methods, according to Grasshoff *et al*., 1999 for the silicate and phosphate, and according to Grasshoff, 1983 for the nitrate and nitrite. The chlorophyll-a will be determined by the spectrophotometric method according to Jeffrey, Humphrey, 1975. And the suspended material will be determined by the gravimetric method according to Strickland, Parsons, 1968. These data will be used to study the water masses characteristics and their distributions patterns.

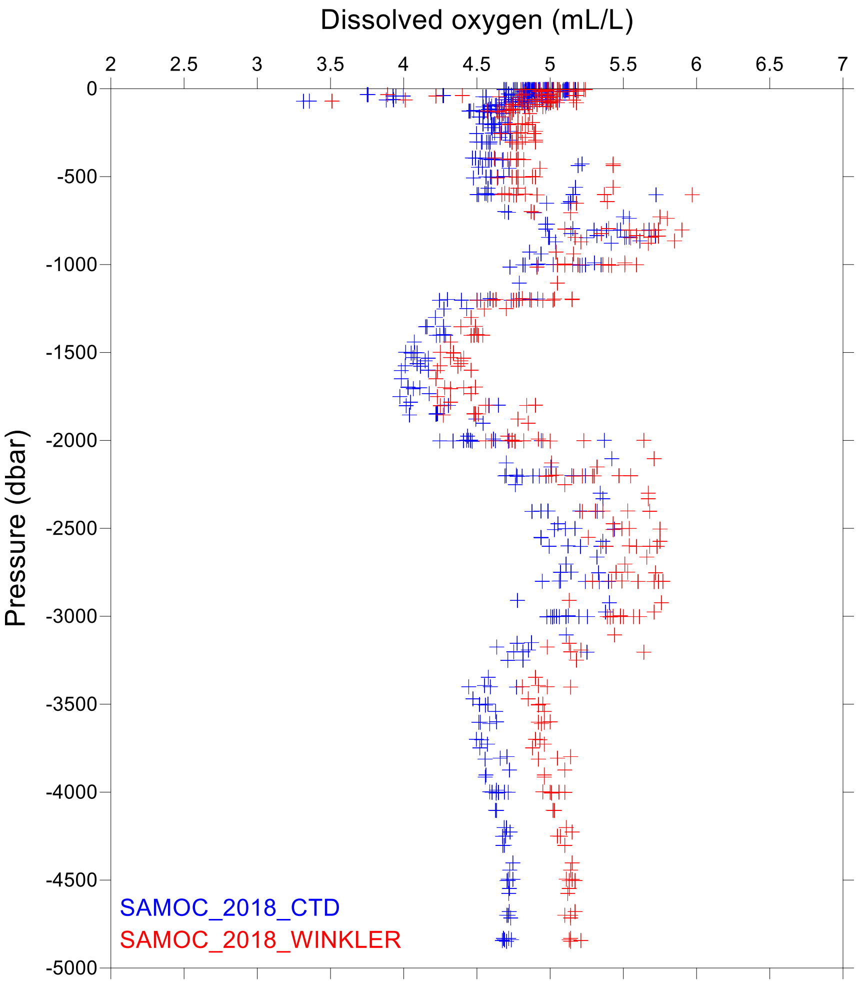


Figure 36. Vertical profile of dissolved oxygen, in blue are the CTD data at the depths of the bottles and in red are the data obtained by Winkler method, SAMOC 2018..

A total of 144 samples for Total Alkalinity (TA) and Dissolved Inorganic Carbon (DIC) were collected along all stations of the SAMBAR 01 Cruise, following the procedure described by Dickson et al. (2007). After the samples for Dissolved Oxygen and pH were obtained, AT and DIC were collected in 250 mL borosilicate flasks, avoiding gas exchange with the atmosphere or any free spaces available, and immediately poisoned with 50 µL of a supersaturated mercury chloride ($HgCl_2$) solution preventing any biological activity interference with the carbonate system parameters. These samples were stored in an adequate place, dark and refrigerated, until transportation to the laboratory.

The TA and DIC analysis will be directly measured by potentiometric titration in a closed-cell, following the method described by Dickson et al. (2007). A solution of hydrochloric acid with sodium chloride 0.1M will be used as a titrant, the sodium chloride is necessary to make sure that the seawater samples will not be diluted or that its ionic strength will not be altered. Certificated Reference Materials (CRMs obtained from A. G. Dickson on Scripps Institution of Oceanography) will be used during the analysis to maintain control and access the precision of the method for TA and DIC.

The results obtained from the analysis, will be processed and used to estimate the other carbonate system parameters, and then, infer about the effects of the global climate change on this system.

pH represents the concentration of H^+ and indicates the conditions of acidity, neutrality or alkalinity of the water. When associated to other parameters, as total alkalinity, the pH gives important information about the carbonate system, which regulates large scale events like ocean acidification. The samplings of water for pH analysis were taken on 60 ml glass bottles and analyzed in the ship laboratory, with the ProLab 3000 pH meter. The measurements were configured to have three decimal places and the equipment was calibrated once every day, using Metrohm buffer sets.

The cruise resulted in 357 samples of DO, 357 samples of nutrients, 95 samples of suspended material and chlorophyll, 32 of alkalinity (Uerj), 144 of alkalinity (FURG), 369 of pH, and 56 of inorganic carbon. The amount of samples collected in each station are at Table XX.

Table XX – Amount of samples for each parameter, for each station.

Date	Station	Depth.(m)	DO	Nutrients	Cl-a	MPS	AT (Uerj)	AT (FURG)	pH	C Inorganic
23/04/2018	1	4000	13	13	3	3	-	-	13	-
25/04/2018	3	16,7	3	3	3	3	2	1	3	4
	4	18,6	3	3	3	3	2	1	3	4
	5	39,6	3	3	3	3	2	1	3	4
	6	75	4	4	4	3	-	2	4	-
	7	45	3	3	3	3	2	1	3	4
	8	69	3	3	3	3	2	2	3	4
	9	128	5	5	5	5	2	2	5	4

	10	165	6	6	6	6	-	2	6	-
	11	400	5	5	3	3	-	4	5	-
	12		-	-	-	-	2	5	8	4
26/04/2018	13	1360	11	11	2	2	2	7	11	4
	14	2538	18	18	5	5	2	8	18	4
	15	2890	21	21	6	6	-	8	21	-
27/04/2018	16	3141	22	22	4	4	2	7	21	4
	17	3493	19	19	4	4	-	8	19	-
	18	3825	20	20	3	3	2	8	22	4
	19	4162	21	21	4	4	-	8	22	-
28/04/2018	20	4373	21	21	4	4	2	7	21	4
	21	4550	23	23	4	4	-	7	23	-
	22	4600	22	22	4	4	2	7	22	2
29/04/2018	23	4645	24	24	4	4	-	8	23	-
	24	4744	21	21	5	5	2	8	21	2
	25	4758	23	23	3	3	-	8	23	-
	26	4764	21	21	3	3	2	12	23	2
30/04/2018	27	4757	22	22	4	4	2	12	23	2
Total of samples			**357**	**357**	**95**	**95**	**32**	**144**	**369**	**56**

5.14 Microbiology Sampling (C. Teixeira)

In order to understand the bacterial and fungal colonies that live in the super-critical thin layer at the ocean surface and in the close atmosphere, seven locations along SAMBA were sampled (Table XXI) along the SAMBAR line. Bacteria and fungi can be used as tracers for atmosphere and ocean circulation and some species are known to be important to cloud formation. The stations were sampled at the inner (CTD station 3), middle (Station 7) and outer shelf (Station 2), the Brazil Current (Stations 11, 14), above a cold eddy that was present at the region (Stations 23) and the last station (27) in the open ocean away from land interference.

Table XXI: Stations with microbiology sampling

2	3	7	11	14	23	27

The atmosphere sampling consisted in keeping three collectors with bacterial and fungal cultures with contact with the air for 30 minutes (Fig 37 a and b). The collectors were then hermetically closed and the cultures will be analyzed at the Microbiology Laboratory of the Marine Sciences Institute (LABOMAR) the Universidade Federal do

Ceará (UFC). The super-critical thin layer was sampled with a paper filter inserted in a sampler floated in the ocean surface for 10 seconds (Fig. 37 c and d). The filter was then inserted in agar culture and will also be analyzed at LABOMAR. The onboard sampling was done by Carlos Teixeira and the analyses will be conducted by Oscarina Souza, both from LABOMAR/UFC.

Fig. 37: Instruments for microbiology sampling, in the atmosphere (a,b) and in the ocean's critical layer (c,d). The samples were collected by C. Teixeira and will be analyzed at LABOMAR/UFC.

Appendices

Annex 1. Documents referent to the equipment shipped by NOAA

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Atlantic Oceanographic and Meteorological Laboratory
4301 Rickenbacker Causeway Miami FL 33149

PRO FORMA INVOICE # _____

Exporter:

N.O.A.A./Atlantic Oceanographic & Meteorological Laboratory
4301 Rickenbacker Causeway
Miami, Florida 33149, U.S.A.
Contact Person: Ulises Rivero
Telephone: 1-305-361-4438
E-mail: ulises.rivero@noaa.gov

Ship to:

Instituto de Astronomia, Geofísica e Ciências Atmosféricas da USP.
Rua do Matão, nº 1226
Cidade Universitária – São Paulo – SP – Brasil
CEP: 05508-090
CNPJ: 63.025.530/0036-34
Attn: Josias Batista de Proença

Manufacturer:

Pressure Inverted Echo Sounder (PIES)

University of Rhode Island
Graduate School of Oceanography
215 South Ferry Road
Narragansett, Rhode Island, 02882, U.S.A.
Telephone: 1-401-874-6507 (Prof. Randy Watts)
E-mail: randywatts@uri.edu

Lithium batteries

Tadiran U.S. Battery Division
2001 Marcus Ave., Suite 125E
Lake Success, New York, 11042, U.S.A.
Telephone: 1-516-621-4980
Fax: 1-516-621-4517

Salinity standard water

Ocean Scientific International Laboratories (OSIL)
Culkin House, C7/C8 Endeavour Business Park, Penner Road
Havant, Hampshire, PO9 1QN, United Kingdom
Telephone: +44 (0)2392 488240
Fax: +44 (0)2392 488241

Weight plates

CAP Barbell
P.O. Box 42213
Houston, Texas, 77242, U.S.A.
Telephone: 1-877-227-0955

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Atlantic Oceanographic and Meteorological Laboratory
4301 Rickenbacker Causeway Miami FL 33149

Goods Description:

Description	Qty	Model#	~Weight (kg)	Country of Origin	Cost/Item (USD)	Total cost (USD)
PIES	3	6.2c	45	U.S.A.	$40,000.00	$120,000.00
20.5Kg plates	8	45LBS	164	U.S.A.	$32.00	$256.00
Lithium batteries	72	TL-5937 3.6 DD	7	U.S.A.	$1.00	$72.00
Standard water	10	P-series	3	U.K.	$56.00	$560.00

Note: For Customs Purposes Only. No Commercial Value

Lithium content:

Qty	Model #	Description	Unit Li Metal Content (grams)	Total Li Metal Content (grams)
72	TL-5937 3.6 DD	Lithium battery	10	720
72	TL-5937 3.6 DD	Lithium battery (installed in PIES)	10	720

Package:

Qty	Dimensions Per Unit (cm)	Weight Per Unit (Kg)	Total Weight (Kg)
Three 55-gallon drums (containing PIES)	L: 57 x W: 57 x H: 85	75	225
Two cardboard boxes (containing batteries)	L: 36 x W: 28 x H: 20	10	20
One cardboard box (containing water)	L: 40 x W: 18 x H: 15	5	5
Four cardboard boxes (containing plates)	L: 40 x W: 40 x H: 10	45	180

Year of Manufacture: PIES (2017); Batteries (2017); Standard water: (2017); Plates (2017)

Validity: for minimum 90 days

Payment Terms: No charge – DONATION

Time in Brazil: Permanent

Delivery: Exworks (EXW)

Shipping Method: Air Freight Collect – by Air Cargo – destination: Guarulhos Airport - São Paulo - Brazil

Signature: ______________ **Date:** 1/23/18

045 | MIA | 31975053 600505142-01

Shipper | Shipper Code NOATLA
N.O.A.A. / ATLANTIC OCEANOGRAPHIC & METEO
ROLOGICAL LABORATORY
4301 RICKENBACKER CAUSEWAY
MIAMI, FL 33149

www.frachtusa.com

Not Negotiable
Air Waybill
Issued by

FRACHT FWO INC. (MIA)
8400 NW 25TH ST
STE 104 BLDG 26
DORAL, FL 33122

Consignee | Consignee Code INSDEA
INSTITUTO DE ASTRONOMIA, GEOFISICA
E CIENCIAS ATMOSFERICAS DA USP.
CNPJ:63.025.530/0036-34
RUA DO MATAO, 1226 - CIDADE
UNIVERSITARIA, SAO PAULO, SP/BRAZIL

PRE ALERT

Issuing Carrier
FRACHT FWO INC. (MIA)
8400 NW 25TH ST
STE 104 BLDG 26

Accounting Information
600505142-01

CAI18104366

Agent's IATA Code: 01-19911/0124
Account No.

Airport of Departure (Addr. of First Carrier) and Requested Routing
MIAMI INT'L AIRPORT

To	By First Carrier	to	by	to	by	Currency	WT/VAL P	WT/VAL C	Other P	Other C	Declared Value for Carriage	Declared Value for Customs
GRU	LA					USD		X		X	NVD	NCV

Airport of Destination	Flight/Date	For Carrier Use Only	Flight/Date	Amount of Insurance
GUARULHOS	8473/26			XXX

INSURANCE - if carrier offers insurance and such insurance is requested in accordance with conditions on reverse hereof indicate amount to be insured in figures in box marked Amount of insurance.

Handling Information
PACKING INFORMATION: 6 CARTONS & 3 PLASTIC PALLETS /// WOODEN PACKAGING NOT APPLICABLE

These commodities licensed by the U.S. for ulitmate destination BRAZIL

Diversion contrary to U.S. law prohibited

No. of Pieces	Gross Weight	kg/lb	Rate Class	Commodity	Chargable Weight	Rate / Charge	Total	Nature and Quantity of Goods (incl. Dimensions or Volume)
9	432.3	K	Q		760.0	4.65	3534.00	SURVEYING, HYDROGRAPHIC, OCEANOGRAPHIC 1 @ 11x14x13 IN 4 @ 16x16x4 IN 1 @ 8x17x6 IN 3 @ 49x41x45 IN
FREIGHT COLLECT								
IAC#: EA9401124								
9	432.3						3,534.00	

	Prepaid	Collect
Weight Charge		3,534.00
Valuation Charge		
Tax		
Total Other Charges Due Agent		1,410.50
Total Other Charges Due Carrier		
Total Prepaid / Total Collect		4,944.50
Currency Conversion Rates / CC Charges in Dest Currency		

Other Charges
CHA 1410.50

Shipper certifies that the particulars on the face hereof are correct and that insofar as any part of the consignment contains dangerous goods, such part is properly described by name and is in proper condition for carriage by air according to the applicable Dangerous Goods Regulations.

FRACHT FWO INC. (MIA)

Signature of Shipper or his Agent

22-MAR-18 MIA DONNA.JAQUEZ

Executed on (date) at (place) Signature of Issuing Carrier or its Agent

For Carriers Use only at Destination	Charges at Destination	Total Collect Charges

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CONSIGNATÁRIO

UNIVERSIDADE DE SAO PAULO

INFORMAÇÕES GERAIS

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VALOR A PAGAR

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VIA - CLIENTE

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Autenticação Mecânica

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Pagável nos bancos Itau, Bradesco ou Banco do Brasil - Não Utilizar o Banco Postal
NÃO RECEBER APÓS VENCIMENTO

CONSIGNATÁRIO

63.025.530/0036-34 - UNIVERSIDADE DE SAO PAULO

15.578.569/0001-06 - CONCESSIONARIA AER. INT. GUARULHOS SA

VIA - BANCO

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Boletos, convênios e outros

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Banco Itaú S.A.

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05508-090 **sao paulo** **SP**

Sacador/Avalista Código de Baixa **109/00003878-5**

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Boletos, convênios e outros

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     COMPROVANTE DE PAGAMENTO DE TITULOS

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NOME FANTASIA:
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4004 0001 Capitais e regioes metropolitanas
0800 729 0001 Demais localidades
Consultas, informacoes e servicos transacionais.

SAC
0800 729 0722
Informacoes, reclamacoes e cancelamento de
produtos e servicos.

Ouvidoria
0800 729 5678
Reclamacoes nao solucionadas nos canais
habituais: agencia, SAC e demais canais de
atendimento.
```

Annex 2: The oil delivered by Petrobras on behalf of SeCIRM

On April 13 and April 16, 2018, on behalf of the Brazilian Navy, Petrobras delivered the oil used during the ship, according to the Invoices (Notas Fiscais) described in the Table below, copies of which are included in this Annex.

	Date	No. NF	Volume delivered (liters)	Value of NF (R$)
1	13-Apr-18	778679	15000	47.134,50
2	13-Apr-18	778683	15000	47.134,50
3	13-Apr-18	778517	15000	47.134,50
4	13-Apr-18	778512	15000	47.134,50
5	16-Apr-18	779223	15000	47.149,50
6	16-Apr-18	779241	15000	47.149,50
7	16-Apr-18	779305	30000	94.299,00
		Totais:	**120.000**	**377.136,00**

Recebi(emos) de **Petrobras Distribuidora S.A.** os produtos constante da Nota Fiscal Eletrônica indicada ao lado, bem como atestamos que os mesmos foram examinados, conforme os testes constantes do Boletim de Conformidade/Certificado de Qualidade, servindo o aceite da **presente para todos os efeitos legais.** Recebemos também o boleto de cobrança respectivo.

DATA DE RECEBIMENTO	IDENTIFICAÇÃO E ASSINATURA DO RECEBEDOR
13/04/18	RAIMUNDO ADALBERTO SOUSA NETO

NF-e
Nº.: 000778679
SÉRIE:

BR PETROBRAS

Petrobras Distribuidora

ENDER Av Joaquim Miguel Couto 1985
BAIRRO VILA PAULISTA
MUNIC CUBATAO UF SP
CEP 11510-010 FONE 40022040

COMPROVANTE DE ENTREGA

0 - ENTRADA
1 - SAIDA [1]

Nº:000778679
SÉRIE:
FOLHA:1/1

CHAVE DE ACESSO
3518 0434 2742 3301 0167 5500 0000 7786 7917 1678 7950

CONSULTA DE AUTENTICIDADE NO PORTAL NACIONAL DA NF-E WWW.NFE.FAZENDA.GOV.BR/PORTAL OU NO SITE DA SEFAZ AUTORIZADORA

PARA DOWNLOAD DO XML ACESSAR SITE WWW.BR.COM.BR

PROTOCOLO DE AUTORIZACAO
135180248792622 13.04.2018 10:45:30

NATUREZA DA OPERACAO
Vd. Cmb. Lub.Adq.ou recb.de 3º dest.a cons.ou usu

INSCR EST	INSCR EST SUBST TRIB	CNPJ
283007808110		34.274.233/0101-67

DESTINATARIO/REMETENTE

NOME/RAZAO SOCIAL			CNPJ/CPF	DATA EMISSAO
COMANDO DA MARINHA CCEM			00.394.502/0050-22	13.04.2018
ENDERECO	BAIRRO/DISTRITO		CEP	DATA DA ENTRADA/SAIDA
PORTO DE SANTOS S/N	PORTUARIO		11100-000	13.04.2018
MUNICIPIO	FONE/FAX	UF	INSCRICAO ESTADUAL	HORA DE ENTRADA/SAIDA
SANTOS	00000013231345	SP		

FATURA
QUARENTA E SETE MIL CENTO E TRINTA E QUATRO REAIS E CINQÜENTA CENTAVOS

CALCULO DO IMPOSTO

BASE CALCULO ICMS	VALOR DO ICMS	BASE DE CALCULO ICMS SUBST	VALOR ICMS SUBST	VALOR TOTAL DOS PRODUTOS
0,00	0,00	0,00	0,00	47.134,50

VALOR DO FRETE	VALOR DO SEGURO	DESCONTO	DESP ACESSORIAS	VALOR DO IPI	VALOR TOTAL DA NOTA
0,00	0,00	0,00	0,00	0,00	47.134,50

TRANSPORTADOR/VOLUMES TRANSPORTADOS

RAZAO SOCIAL	FRETE P/ CONTA	C ANTT	PLACA VEICULO	UF	CNPJ/CPF
COOPERATIVA DE TRANSPORTE	0 - Emitente		FWM6930	SP	59.303.123/000

ENDERECO	MUNICIPIO	UF	INSCR ESTADUAL
RUA PINTO FERRAZ 76	SAO CAETANO DO SUL	SP	636027934118

QUANTIDADE	ESPECIE	MARCA	NUMERACAO	PESO BRUTO	PESO LIQUIDO
15000	GRANEL			12.741,000 KG	12.741,000 K

DADOS DO PRODUTO SERVICO

COD	DESCR PROD	NCM/SH	CST	CFOP	UNID	QUANT	V UNIT	V TOTAL	BC ICMS	V ICMS	V IPI
[illegible]	OLEO DIESEL MARITIMO A	27101921	060	5656	L	15.000,000	3,1423	47.134,50	0,00	0,00	0,00

ONU 1202 OLEO DIESEL 3 III
ICMS retido na fonte conforme Conv ICMS 110/07 - BC R$ 49.155,60 - ICMS retido R$ 5.898,60
IPI não tributado ou aliquota zero cf. Decreto 7660/2011 do MF
Central BR 4002 2040 ou 0800 282 20 40. Caso não estejam ativos, ligue (21) 3876 5959
Tanque 1478 - Boletim Conf 050001662993
Valor aproximado dos tributos Federais R$ 7.672,50 , Estaduais R$ 5.898,60 , Municipais R$ 0,00

OBS: NÃO FOI RECEBIDA AMOSTRA ÓLEO

Raimundo Adalberto de Sousa Neto
1º OM - Chefe de Máquinas
NOc "ALPHA - CRUCIS"

NAVIO OCEANOGRÁFICO ALPHA CRUCIS
Instituto Oceanográfico - USP

CALCULO DO ISSQN

INSCR MUNIC	VALOR TOTAL DOS SERVICOS	BASE DE CALCULO DO ISSQN	VALOR DO ISSQN
	0,00	0,00	0,00

RESERVADO AO FISCO

DADOS ADICIONAIS
INFORMACOES COMPLEMENTARES [illegible] TEAT SERIE NFE 05/2007 DE 21/12/2007 Motorista: ADRIANO CARLOS DA [illegible] 66759776 66759777 [illegible] 66759771 66759772 66759773 66759774 66759775 [illegible] Carta 025/2017 - COMRJ-2017 OC 1096496 N/OCC [illegible] Contrato [illegible] CAIS DO PORTO DE SANTOS ARMAZEM 7 8 MACUCO [illegible] ALPHA CRUCIS [illegible] No. [illegible]-4524: fabricação e serviços associados para óleos lubes [illegible] Ord.Venda(s): 0240750218 - Numero do [illegible] Vendas 2031 Remessa FA - Ord.Venda(s): [illegible] Contrato(s): 0040360238 Conceito de [illegible] - Faturamento: 4154193379 - Contrato(s): 4040360238 Conceito de [illegible] Remessa por conta de Faturamento Antecipado [illegible] Transporte: 40278[illegible]26 [illegible] CIF - Rodoviario Valor aproximado dos tributos Federais: R$ [illegible] Municipais: R$ 0,00 . Declaro que os produtos [illegible] estão adequadamente classificados, embalados, identificados, e estivados para [illegible] às exigências da [illegible] de transporte e que atendem às exigências da [illegible] de 16/10/2017 Aliquota zero de PIS e de [illegible] conforme nota fiscal [illegible] 154-35/2001, art. 42, inciso I [illegible] da Medida Provisória n. 2.158-35/2001

Recebi(emos) de **Petrobras Distribuidora S.A.** os produtos constante da Nota Fiscal Eletrônica indicada ao lado, bem como atestamos que os mesmos foram examinados, conforme os testes constantes do Boletim de Conformidade/Certificado de Qualidade, servindo o **aceite da presente para todos os efeitos legais**. Recebemos também o boleto de cobrança respectivo

DATA DE RECEBIMENTO	IDENTIFICAÇÃO E ASSINATURA DO RECEBEDOR
13/04/18	RAIMUNDO ADALBERTO SOUSA NETO

NF-e
Nº.: 000778683
SÉRIE:

BR PETROBRAS

Petrobras Distribuidora

ENDER Av. Joaquim Miguel Couto 1985
BAIRRO VILA PAULISTA
MUNIC CUBATAO DE SP
CEP 11510-010 FONE 40022040

COMPROVANTE DE ENTREGA

0 - ENTRADA
1 - SAIDA [1]

Nº:000778683
SÉRIE:
FOLHA:1/1

CHAVE DE ACESSO
3518 0434 2742 3301 0167 5500 0000 7786 8317 4403 7628

CONSULTA DE AUTENTICIDADE NO PORTAL NACIONAL DA NF-E WWW.NFE.FAZENDA.GOV.BR/PORTAL OU NO SITE DA SEFAZ AUTORIZADORA

PARA DOWNLOAD DO XML ACESSAR SITE WWW.BR.COM.BR

NATUREZA DA OPERACAO	PROTOCOLO DE AUTORIZACAO
Vd. Cmb./Lub.Adq.ou recb.de 3º dest.a cons.ou usu	135180248919535 13.04.2018 11:14:17

INSCR EST	INSCR EST SUBST TRIB	CNPJ
283007808110		34.274.233/0101-67

DESTINATARIO/REMETENTE

NOME/RAZAO SOCIAL				CNPJ/CPF	DATA EMISSAO
COMANDO DA MARINHA CCEM				00.394.502/0050-22	13.04.2018
ENDERECO		**BAIRRO/DISTRITO**		**CEP**	**DATA DA ENTRADA/SAIDA**
PORTO DE SANTOS S/N		PORTUARIO		11100-000	13.04.2018
MUNICIPIO	**FONE/FAX**	**UF**	**INSCRIÇÃO ESTADUAL**		**HORA DE ENTRADA/SAIDA**
SANTOS	00000013231345	SP			

FATURA

QUARENTA E SETE MIL CENTO E TRINTA E QUATRO REAIS E CINQÜENTA CENTAVOS

CALCULO DO IMPOSTO

BASE CALCULO ICMS	VALOR DO ICMS	BASE DE CALCULO ICMS SUBST	VALOR ICMS SUBST	VALOR TOTAL DOS PRODUTOS
0,00	0,00	0,00	0,00	47.134,50

VALOR DO FRETE	VALOR DO SEGURO	DESCONTO	DESP ACESSORIAS	VALOR DO IPI	VALOR TOTAL DA NOTA
0,00	0,00	0,00	0,00	0,00	47.134,50

TRANSPORTADOR/VOLUMES TRANSPORTADOS

RAZAO SOCIAL	FRETE P/ CONTA	C ANTT	PLACA VEICULO	UF	CNPJ/CPF
COOPERATIVA DE TRANSPORTE	0 - Emitente		FVO9067	SP	59.303.123/0001-4

ENDERECO	MUNICIPIO	UF	INSCR ESTADUAL
RUA PINTO FERRAZ 76	SAO CAETANO DO SUL	SP	636027934118

QUANTIDADE	ESPECIE	MARCA	NUMERACAO	PESO BRUTO	PESO LIQUIDO
15000	GRANEL			12.747,000 KG	12.747,000 KG

DADOS DO PRODUTO SERVICO

COD	DESCR PROD	NCM SH	CST	CFOP	UNID	QUANT	V UNIT	V TOTAL	BC ICMS	V ICMS	V IPI	ALIQ %ICMS
01.000.199	OLEO DIESEL MARITIMO A	27101921	060	5656	L	15.000,000	3,1423	47.134,50	0,00	0,00	0,00	0,00

ONU 1202 OLEO DIESEL 3 III
ICMS retido na fonte conforme Conv ICMS 110/07 - BC R$ 49.155,00 - ICMS retido R$ 5.898,60
IPI não tributado ou alíquota zero cf. Decreto 7660/2011 do MF
Central BR 4002 2040 ou 0800 282 20 40 . Caso não estejam ativos ligue (21) 3876 5959
Temp [illegible] 14°C - Boletim Conf [illegible]
Valor aproximado dos tributos Federais R$ 7.672,50 , Estaduais R$ 5.898,60 , Municipais R$ 0,00

OBS: NÃO FOI RECEBIDA AMOSTRA OLEO

NAVIO OCEANOGRÁFICO ALPHA CRUCIS
Instituto Oceanográfico - USP

Raimundo Adalberto de Sousa Neto
1º OM - Chefe de Máquinas
NOc "ALPHA CRUCIS"

CALCULO DO ISSQN

INSCR MUNIC	VALOR TOTAL DOS SERVICOS	BASE DE CALCULO DO ISSQN	VALOR DO ISSQN
	0,00	0,00	0,00

DADOS ADICIONAIS

INFORMACOES COMPLEMENTARES
[illegible] Motorista: ANDERSON CARLOS [illegible] 66759786 66759768 [illegible] - COMRJ-SAI [illegible] PORTO DE SANTOS ARMAZEM [illegible] e serviços associados para óleos [illegible] Remessa [illegible] - Numero do [illegible] Conceito de [illegible] Remessa por conta de Faturamento Antecipado [illegible] aproximado dos tributos Federais: R$ [illegible] Municipais: R$ [illegible]. Declaro que os produtos [illegible] classificados, embalados, identificados, e estivados para [illegible] das operações de transporte e que atendem às exigências da [illegible] conforme nota fiscal [illegible] Alíquota zero de PIS e de [illegible] da Med.do Provisória [illegible], art. 42, inciso I

RESERVADO AO FISCO

Recebi(emos) de **Petrobras Distribuidora S.A.** os produtos constante da Nota Fiscal Eletrônica indicada ao lado, bem como atestamos que os mesmos foram examinados, conforme os testes constantes do Boletim de Conformidade/Certificado de Qualidade, servindo o **aceite da presente para todos os efeitos legais**. Recebemos também o boleto de cobrança respectivo

DATA DE RECEBIMENTO	IDENTIFICAÇÃO E ASSINATURA DO RECEBEDOR
13/04/2018	RAIMUNDO ADALBERTO SOUSA NETO

NF-e
Nº.: 00077851
SÉRIE:

PETROBRAS

Petrobras Distribuidora

ENDER Av Joaquim Miguel Couto 1985
BAIRRO VILA PAULISTA
MUNIC CUBATAO UF SP
CEP 11510-010 FONE 40022040

COMPROVANTE DE ENTREGA

0 - ENTRADA
1 - SAIDA [1]

Nº:000778517
SÉRIE:
FOLHA:1/1

CHAVE DE ACESSO
3518 0434 2742 3301 0167 5500 0000 7785 1713 5986 2729

CONSULTA DE AUTENTICIDADE NO PORTAL NACIONAL DA NF-E WWW.NFE.FAZENDA.GOV.BR/PORTAL OU NO SITE DA SEFAZ AUTORIZADORA

NATUREZA DA OPERACAO	PROTOCOLO DE AUTORIZACAO
Vd. Cmb./Lub.Adq.ou recb.de 3° dest.a cons.ou usu	135180247992927 13.04.2018 04:25:50

INSCR EST	INSCR EST SUBST TRIB	CNPJ
283007808110		34.274.233/0101-67

DESTINATARIO/REMETENTE

NOME/RAZAO SOCIAL			CNPJ/CPF	DATA EMISSAO
COMANDO DA MARINHA CCEM			00.394.502/0050-22	13.04.2018
ENDERECO	**BAIRRO/DISTRITO**		**CEP**	**DATA DA ENTRADA/SAIDA**
PORTO DE SANTOS S/N	PORTUARIO		11100-000	13.04.2018
MUNICIPIO	**FONE/FAX**	**UF**	**INSCRIÇÃO ESTADUAL**	**HORA DE ENTRADA/SAIDA**
SANTOS	00000013231345	SP		

FATURA

QUARENTA E SETE MIL CENTO E TRINTA E QUATRO REAIS E CINQÜENTA CENTAVOS

CALCULO DO IMPOSTO

BASE CALCULO ICMS	VALOR DO ICMS	BASE DE CALCULO ICMS SUBST	VALOR ICMS SUBST		VALOR TOTAL DOS PRODUTOS
0,00	0,00	0,00	0,00		47.134,50
VALOR DO FRETE	**VALOR DO SEGURO**	**DESCONTO**	**DESP ACESSORIAS**	**VALOR DO IPI**	**VALOR TOTAL DA NOTA**
0,00	0,00	0,00	0,00	0,00	47.134,50

TRANSPORTADOR/VOLUMES TRANSPORTADOS

RAZAO SOCIAL		FRETE P/ CONTA	C ANTT	PLACA VEICULO	UF	CNPJ/CPF
COOPERATIVA DE TRANSPORTE		0 - Emitente		FVO9067	SP	59.303.123/000
ENDERECO		**MUNICIPIO**			**UF**	**INSCR ESTADUAL**
RUA PINTO FERRAZ 76		SAO CAETANO DO SUL			SP	636027934118

QUANTIDADE	ESPECIE	MARCA	NUMERACAO	PESO BRUTO	PESO LIQUIDO
15000	GRANEL			12.750,000 KG	12.750,000 K

DADOS DO PRODUTO/SERVICO

COD	DESCR PROD	NCM/SH	CST	CFOP	UNID	QUANT	V.UNIT	V.TOTAL	BC ICMS	V ICMS	V IPI	%
01.000.0	OLEO DIESEL MARITIMO A	27101921	060	5656	L	15.000,000	3,1423	47.134,50	0,00	0,00	0,00	0,0

ONU 1202 OLEO DIESEL 3 III
ICMS retido na fonte conforme Conv ICMS 110/07 - BC R$ 49.155,00 - ICMS retido R$ 5.898,60
IPI não tributado ou alíquota zero cf. Decreto 7660/2011 do MF
Central BR 4002 2040 ou 0800 282 20 40. Caso não estejam ativos, ligue (21) 3876 5959
Tanque 1478 Boletim Conf 0500010029[illegible]
Valor aproximado dos tributos Federais R$ 7.072,50 Estaduais R$ 5.898,60 Municipais R$ 0,00

OBS: NÃO FOI RECEBIDA AMOSTRA ÓLEO

Raimundo Adalberto de Sousa Neto
1° OM - Chefe de Máquinas
NOc "ALPHA - CRUCIS"

CALCULO DO ISSQN

INSCR MUNIC	VALOR TOTAL DOS SERVICOS	BASE DE CALCULO DO ISSQN	VALOR DO ISSQN
	0,00	0,00	0,00

DADOS ADICIONAIS

INFORMACOES COMPLEMENTARES
[illegible] Motorista: ANDERSON CARLOS [illegible] COMRJ-2017 OC 1036496 N/OCE [illegible] ALPHA CRUCIS CAIS [illegible] PORTO DE SANTOS ARMAZEM [illegible] MACUCO [illegible] fabricação e serviços associados para óleos lubrif [illegible] Remessa FA - Ord.Venda [illegible] - Numero do [illegible] - Contrato [illegible] Conceito de [illegible] Remessa por conta de Faturamento Antecipado [illegible] Valor aproximado dos tributos Federais R$ [illegible] Municipais R$ [illegible] Declaro que os produtos [illegible] classificados, embalados, identificados, e estivados para [illegible] das operações de Transporte e que atendem as exigências da [illegible] Alíquota zero de PIS e de [illegible]

RESERVADO AO FISCO

Recebi(emos) de **Petrobras Distribuidora S.A.** os produtos constante da Nota Fiscal Eletrônica indicada ao lado, bem como atestamos que os mesmos foram examinados, conforme os testes constantes do Boletim de Conformidade/Certificado de Qualidade, **servindo o aceite da presente para todos os efeitos legais**. Recebemos também o boleto de cobrança respectivo.

DATA DE RECEBIMENTO	IDENTIFICAÇÃO E ASSINATURA DO RECEBEDOR
13/04/2018	RAIMUNDO ADALBERTO DE SOUSA NETO

NF-e
Nº.: 000778512
SÉRIE:

PETROBRAS

Petrobras Distribuidora

ENDER Av Joaquim Miguel Couto 1985
BAIRRO VILA PAULISTA
MUNIC CUBATAO UF SP
CEP 11510-010 FONE 40022040

COMPROVANTE DE ENTREGA

0 - ENTRADA
1 - SAIDA [1]

Nº:000778512
SÉRIE:
FOLHA:1/1

CHAVE DE ACESSO
3518 0434 2742 3301 0167 5500 0000 7785 1213 2111 1479

CONSULTA DE AUTENTICIDADE NO PORTAL NACIONAL DA NF-E WWW.NFE.FAZENDA.GOV.BR/PORTAL OU NO SITE DA SEFAZ AUTORIZADORA

PARA CONSULTA DO XML ACESSAR SITE WWW.BR...

NATUREZA DA OPERACAO	PROTOCOLO DE AUTORIZACAO
Vd. Cmb./Lub.Adq.ou recb.de 3º dest.a cons.ou usu	135180247968949 13.04.2018 03:44:42

INSCR EST	INSCR EST SUBST TRIB	CNPJ
283007808110		34.274.233/0101-67

DESTINATARIO/REMETENTE

NOME/RAZAO SOCIAL		CNPJ/CPF	DATA EMISSAO
COMANDO DA MARINHA CCEM		00.394.502/0050-22	13.04.2018
ENDERECO	BAIRRO/DISTRITO	CEP	DATA DA ENTRADA/SAIDA
PORTO DE SANTOS S/N	PORTUARIO	11100-000	13.04.2018

MUNICIPIO	FONE/FAX	UF	INSCRIÇÃO ESTADUAL	HORA DE ENTRADA/SAIDA
SANTOS	00000013231345	SP		

FATURA

QUARENTA E SETE MIL CENTO E TRINTA E QUATRO REAIS E CINQÜENTA CENTAVOS

CALCULO DO IMPOSTO

BASE CALCULO ICMS	VALOR DO ICMS	BASE DE CALCULO ICMS SUBST	VALOR ICMS SUBST	VALOR TOTAL DOS PRODUTOS
0,00	0,00	0,00	0,00	47.134,50

VALOR DO FRETE	VALOR DO SEGURO	DESCONTO	DESP ACESSORIAS	VALOR DO IPI	VALOR TOTAL DA NOTA
0,00	0,00	0,00	0,00	0,00	47.134,50

TRANSPORTADOR/VOLUMES TRANSPORTADOS

RAZAO SOCIAL	FRETE P/ CONTA	C ANTT	PLACA VEICULO	UF	CNPJ/CPF
COOPERATIVA DE TRANSPORTE	0 - Emitente		FWM6930	SP	59.303.123/0001-

ENDERECO	MUNICIPIO	UF	INSCR ESTADUAL
RUA PINTO FERRAZ 76	SAO CAETANO DO SUL	SP	636027934118

QUANTIDADE	ESPECIE	MARCA	NUMERACAO	PESO BRUTO	PESO LIQUIDO
15000	GRANEL			12.747,000 KG	12.747,000 KG

DADOS DO PRODUTO/SERVICO

COD	DESCR PROD	NCM/SH	CST	CFOP	UNID	QUANT	V UNIT	V TOTAL	BC ICMS	V ICMS	V IPI	ALIQ %ICMS
01000 100	OLEO DIESEL MARITIMO A	27101921	000	5656	L	15.000,000	3,1423	47.134,50	0,00	0,00	0,00	0,00

ONU 1202 OLEO DIESEL 3 III
ICMS retido na fonte conforme Conv ICMS 110/07 - BC R$ 40.155,60 - ICMS retido R$ 5.898,60
IPI não tributado ou aliquota zero cf. Decreto 7660/2011 do MF
Central BR 4002 2040 ou 0800 282 20 40. Caso não estejam ativos, ligue (21) 3876 5959
Tanque 1478 - Boletim Conf 0500001862993
Valor aproximado dos tributos Federais: R$ 7.672,50 Estaduais: R$ 5.808,60 Municipais: R$ 0,00

OBS: NÃO FOI RECEBIDA AMOSTRA ÓLEO

Raimundo Adalberto de Sousa Neto
1º OM - Chefe de Máquinas
NOc "ALPHA - CRUCIS"

NAVIO OCEANOGRÁFICO ALPHA CRUCIS
Instituto Oceanográfico - USP

CALCULO DO ISSQN

INSCR MUNIC	VALOR TOTAL DOS SERVICOS	BASE DE CALCULO DO ISSQN	VALOR DO ISSQN
	0,00	0,00	0,00

DADOS ADICIONAIS

INFORMACOES COMPLEMENTARES

[illegible] Motorista: ADRIANO CARLOS DA [illegible] - COMBUSTIVEL [illegible] ALPHA CRUCIS [illegible] PORTO DE SANTOS ARMAZEM [illegible] fabricação e serviços associados para oleos [illegible] Remessa FA - Ord. Venda [illegible] - Numero do [illegible] Contrato [illegible] Conceito de [illegible] Remessa por conta de Faturamento Antecipado [illegible] Valor aproximado dos tributos Federais: R$ [illegible] Municipais: R$ [illegible]. Declaro que os produtos [illegible] classificados, embalados, identificados, e estivados para [illegible] de transporte e que atendem às exigências da [illegible] de 10/12/2017 Aliquota zero de PIS e de

RESERVADO AO FISCO

Recebi(emos) de **Petrobras Distribuidora S.A.** os produtos constante da Nota Fiscal Eletrônica indicada ao lado, bem como atestamos que os mesmos foram examinados, conforme os testes constantes do Boletim de Conformidade/Certificado de Qualidade, servindo o aceite da presente para todos os efeitos legais. Recebemos também o boleto de cobrança respectivo

DATA DE RECEBIMENTO	IDENTIFICAÇÃO E ASSINATURA DO RECEBEDOR
16/04/18	RAIMUNDO ADALBERTO SOUSA NETO

NF-e
Nº.: 0007792
SÉRIE:

PETROBRAS

Petrobras Distribuidora

ENDER Av. Joaquim Miguel Couto 1985
BAIRRO VILA PAULISTA
MUNIC CUBATAO UF SP
CEP 11510-010 FONE 40022040

COMPROVANTE DE ENTREGA

0 - ENTRADA
1 - SAIDA [1]

Nº:000779223
SÉRIE:
FOLHA:1/1

CHAVE DE ACESSO
3518 0434 2742 3301 0167 5500 0000 7792 2314 3822 469

CONSULTA DE AUTENTICIDADE NO PORTAL NACIONAL DA NF-E WWW.NFE.FAZENDA.GOV.BR/PORTAL OU NO SITE DA SEFAZ AUTORIZADORA

NATUREZA DA OPERACAO	PROTOCOLO DE AUTORIZACAO
Vd. Cmb./Lub.Adq.ou recb.de 3º dest.a cons.ou usu	135180252411492 16 04 2018 04 43 46

INSCR EST	INSCR EST SUBST TRIB	CNPJ
283007808110		34.274.233/0101-67

DESTINATARIO/REMETENTE

NOME RAZAO SOCIAL				CNPJ/CPF	DATA EMISSA
COMANDO DA MARINHA CCEM				00.394.502/0050-22	16.04.201
ENDERECO		**BAIRRO DISTRITO**		**CEP**	**DATA DA ENTRADA SA**
PORTO DE SANTOS S/N		PORTUARIO		11100-000	16.04.201
MUNICIPIO	**FONE/FAX**	**UF**	**INSCRIÇÃO ESTADUAL**		**HORA DE ENTRADA SA**
SANTOS	00000013231345	SP			

FATURA

QUARENTA E SETE MIL CENTO E QUARENTA E NOVE REAIS E CINQÜENTA CENTAVOS

CALCULO DO IMPOSTO

BASE CALCULO ICMS	VALOR DO ICMS	BASE DE CALCULO ICMS SUBST	VALOR ICMS SUBST	VALOR TOTAL DOS PRODUTO
0,00	0,00	0,00	0,00	47.149,50

VALOR DO FRETE	VALOR DO SEGURO	DESCONTO	DESP ACESSORIAS	VALOR DO IPI	VALOR TOTAL DA NOTA
0,00	0,00	0,00	0,00	0,00	47.149,50

TRANSPORTADOR/VOLUMES TRANSPORTADOS

RAZAO SOCIAL	FRETE P. CONTA	C ANTT	PLACA VEICULO	UF	CNPJ/CPF
COOPERATIVA DE TRANSPORTE	0 - Emitente		FVO9067	SP	59.303.123/0001

ENDERECO	MUNICIPIO	UF	INSCR ESTADUAL
RUA PINTO FERRAZ 76	SAO CAETANO DO SUL	SP	636027934118

QUANTIDADE	ESPECIE	MARCA	NUMERACAO	PESO BRUTO	PESO LIQUIDO
15000	GRANEL			12.753,000 KG	12.753,000 KG

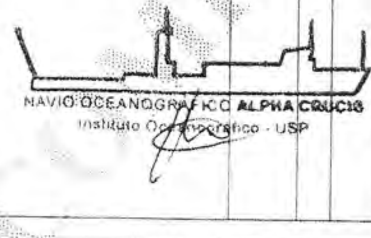
DADOS DO PRODUTO SERVICO

COD	DESCR PROD	NCM/SH	CST	CFOP	UNID	QUANT	V UNIT	V TOTAL	BC ICMS	V ICMS	V IPI
[illegible]	OLEO DIESEL MARITIMO A	27101921	060	5656	L	15.000,000	3,1433	47.149,50	0,00	0,00	0,00

ONU 1202 OLEO DIESEL 3 III
ICMS retido na fonte conforme Conv. ICMS 110/07 - BC R$ 49.275,00 - ICMS retido R$ 5.913,00
IPI não tributado ou alíquota zero cf. Decreto 7660/2011 do MF
Central BR: 4002 2040 ou 0800 282 20 40. Caso não estejam ativos, ligue (21) 3876 5959
Tanque 1478 - Boletim Conf. 05000160299[illegible]
Valor aproximado dos tributos Federais R$ 7.672,50 , Estaduais R$ 5.913,00 , Municipais R$ 0,00

OBS: NÃO FOI RECEBIDA AMOSTRA ÓLEO

Raimundo Adalberto de Sousa Neto
1º OM - Chefe de Máquinas
NOc "ALPHA - CRUCIS"



CALCULO DO ISSQN

INSCR MUNIC	VALOR TOTAL DOS SERVICOS	BASE DE CALCULO DO ISSQN	VALOR DO ISSQN
	0,00	0,00	0,00

DADOS ADICIONAIS

INFORMACOES COMPLEMENTARES

[illegible] de 21/12/2007 Motorista: ANDERSON CARL[illegible] [illegible] Carta 022/2017 [illegible] CAIS DO PORTO DE SANTOS ARMAZEM [illegible] certificação e serviços associados para [illegible] Ord.Venda [illegible] - Contrato [illegible] Remessa por conta de Faturamento Antecipad[illegible] Rodoviário Valor aproximado dos tributos Federais: R$ [illegible] Estaduais: R$ [illegible], Municipais: R$ 0,00 . Declaro que os produtos [illegible] estão adequadamente classificados, embalados, identificados, e estivados para suportar os riscos das operações de transporte e que atendem às exigências da regulamentação. Conforme nota fiscal [illegible] de 16/12/2017 Alíquota zero de PIS e de COFINS, nos termos da Medida Provisória n. 2.158-35/2001, art. 42, inciso I

RESERVADO AO FISCO

Recebi(emos) de **Petrobras Distribuidora S.A.** os produtos constante da Nota Fiscal Eletrônica indicada ao lado, bem como atestamos que os mesmos foram examinados, conforme os testes constantes do Boletim de Conformidade/Certificado de Qualidade, **servindo o aceite da presente para todos os efeitos legais**. Recebemos também o boleto de cobrança respectivo.

DATA DE RECEBIMENTO	IDENTIFICAÇÃO E ASSINATURA DO RECEBEDOR
16/04/18	RAIMUNDO ADALBERTO SOUSA NETO

NF-e
Nº.: 0007792
SÉRIE:

BR PETROBRAS

Petrobras Distribuidora

ENDER Av Joaquim Miguel Couto 1985
BAIRRO VILA PAULISTA
MUNIC CUBATAO UF SP
CEP 11510-010 FONE 40022040

COMPROVANTE DE ENTREGA

0 - ENTRADA
1 - SAIDA [1]

Nº:000779241
SÉRIE:
FOLHA:1/1

CHAVE DE ACESSO
3518 0434 2742 3301 0167 5500 0000 7792 4114 6505 12

CONSULTA DE AUTENTICIDADE NO PORTAL NACIONAL DA NF-E WWW.NFE.FAZENDA.GOV.BR/PORTAL OU NO SITE DA SEFAZ AUTORIZADORA

NATUREZA DA OPERACAO	PROTOCOLO DE AUTORIZACAO
Vd. Cmb./Lub.Adq.ou recb.de 3º dest.a cons.ou usu	135180252418112 16.04.2018 05:12:14

INSCR EST	INSCR EST SUBST TRIB	CNPJ
283007808110		34.274.233/0101-67

DESTINATÁRIO/REMETENTE

NOME RAZAO SOCIAL			CNPJ CPF	DATA EMISS
COMANDO DA MARINHA CCEM			00.394.502/0050-22	16.04.20

ENDERECO	BAIRRO DISTRITO	CEP	DATA DA ENTRADA/S
PORTO DE SANTOS S/N	PORTUARIO	11100-000	16.04.20

MUNICIPIO	FONE/FAX	UF	INSCRIÇÃO ESTADUAL	HORA DE ENTRADA/S
SANTOS	00000013231345	SP		

FATURA

QUARENTA E SETE MIL CENTO E QUARENTA E NOVE REAIS E CINQÜENTA CENTAVOS

CALCULO DO IMPOSTO

BASE CALCULO ICMS	VALOR DO ICMS	BASE DE CALCULO ICMS SUBST	VALOR ICMS SUBST	VALOR TOTAL DOS PRODUT
0,00	0,00	0,00	0,00	47.149,50

VALOR DO FRETE	VALOR DO SEGURO	DESCONTO	DESP ACESSORIAS	VALOR DO IPI	VALOR TOTAL DA NOTA
0,00	0,00	0,00	0,00	0,00	47.149,50

TRANSPORTADOR/VOLUMES TRANSPORTADOS

RAZAO SOCIAL	FRETE P/ CONTA	C ANTT	PLACA VEICULO	UF	CNPJ CPF
COOPERATIVA DE TRANSPORTE	0 - Emitente		FWM6930	SP	59.303.123/00

ENDERECO	MUNICIPIO	UF	INSCR ESTADUAL
RUA PINTO FERRAZ 76	SAO CAETANO DO SUL	SP	636027934118

QUANTIDADE	ESPECIE	MARCA	NUMERACAO	PESO BRUTO	PESO LIQUIDO
15000	GRANEL			12.753,000 KG	12.753,000 K

DADOS DO PRODUTO SERVICO

COD	DESCR PROD	NCM/SH	CST	CFOP	UNID	QUANT	V UNIT	V TOTAL	BC ICMS	V ICMS	V IPI
11000109	OLEO DIESEL MARITIMO A	27101921	060	5656	L	15.000,000	3,1433	47.149,50	0,00	0,00	0,00
	ONU 1202 OLEO DIESEL 3 III										
	ICMS retido na fonte conforme Conv ICMS 110/07 - BC R$ 49.275,00 - ICMS retido R$ 5.913,00										
	IPI não tributado ou alíquota zero cf. Decreto 7660/2011 do MF										
	Central BR 4002 2040 ou 0800 282 2040. Caso não estejam aux os. Rgns (21) 3876 5959										
	Tanque 1478 - Boletim Conf. 05000160209										
	Valor aproximado dos tributos Federais R$ 7.672,50, Estaduais R$ 5.913,00, Municipais R$ 0,00										

OBS: NÃO FOI RECEBIDO AMOSTRA ÓLEO

NAVIO OCEANOGRÁFICO ALPHA CRUCIS
Instituto Oceanográfico - USP

Raimundo Adalberto de Sousa Neto
1º Ofl - Chefe de Máquinas
NOc "ALPHA - CRUCIS"

CALCULO DO ISSQN

INSCR MUNIC	VALOR TOTAL DOS SERVICOS	BASE DE CALCULO DO ISSQN	VALOR DO ISSQN
	0,00	0,00	0,00

DADOS ADICIONAIS

INFORMACOES COMPLEMENTARES

[illegible] Motorista: LIOMAR CARLOS [illegible] Remessa por conta de Faturamento Antecipado [illegible] Valor aproximado dos tributos Federais: R$ [illegible], Municipais: R$ 0,00 . Declaro que os produtos [illegible] classificados, embalados, identificados, e estivados para [illegible] das operações de transporte e que atendem as exigências da [illegible] de 14/12/2017 Alíquota zero de [illegible] Medida Provisória n. 2.158-35/2001, art. 42, inciso I

RESERVADO AO FISCO

Recebi(emos) de **Petrobras Distribuidora S.A.** os produtos constante da Nota Fiscal Eletrônica indicada ao lado, bem como atestamos que os mesmos foram examinados, conforme os testes constantes do Boletim de Conformidade/Certificado de Qualidade, servindo o aceite da presente para todos os efeitos legais. Recebemos também o boleto de cobrança respectivo.

DATA DE RECEBIMENTO	IDENTIFICACAO E ASSINATURA DO RECEBEDOR	NF-e
16/04/2018	RAIMUNDO ADALBERTO SOUSA NETO	Nº.: 000779305 SÉRIE:

PETROBRAS

Petrobras Distribuidora

ENDER Av. Joaquim Miguel Couto 1985

BAIRRO VILA PAULISTA

MUNIC CUBATAO UF SP

CEP 11510-010 FONE 40022040

COMPROVANTE DE ENTREGA

0 - ENTRADA
1 - SAIDA [1]

Nº:000779305
SÉRIE:
FOLHA:1/2

CHAVE DE ACESSO
3518 0434 2742 3301 0167 5500 0000 7793 0516 2806 3539

CONSULTA DE AUTENTICIDADE NO PORTAL NACIONAL DA NF-E WWW.NFE.FAZENDA.GOV.BR/PORTAL OU NO SITE DA SEFAZ AUTORIZADORA

NATUREZA DA OPERACAO	PROTOCOLO DE AUTORIZACAO
Vd. Cmb./Lub.Adq.ou recb.de 3º dest.a cons.ou usu	135180252549198 16.04.2018 08:05:36

INSCR EST	INSCR EST SUBST TRIB	CNPJ
283007808110		34.274.233/0101-67

DESTINATARIO/REMETENTE

NOME RAZAO SOCIAL			CNPJ CPF	DATA EMISSAO
COMANDO DA MARINHA CCEM			00.394.502/0050-22	16.04.2018
ENDERECO	**BAIRRO DISTRITO**		**CEP**	**DATA DA ENTRADA SAIDA**
PORTO DE SANTOS S/N	PORTUARIO		11100-000	16.04.2018
MUNICIPIO	**FONE/FAX**	**UF**	**INSCRICAO ESTADUAL**	**HORA DE ENTRADA SAIDA**
SANTOS	00000013231345	SP		

FATURA

NOVENTA E QUATRO MIL DUZENTOS E NOVENTA E NOVE REAIS

CALCULO DO IMPOSTO

BASE CALCULO ICMS	VALOR DO ICMS	BASE DE CALCULO ICMS SUBST	VALOR ICMS SUBST	VALOR TOTAL DOS PRODUTOS
0,00	0,00	0,00	0,00	94.299,00

VALOR DO FRETE	VALOR DO SEGURO	DESCONTO	DESP. ACESSORIAS	VALOR DO IPI	VALOR TOTAL DA NOTA
0,00	0,00	0,00	0,00	0,00	94.299,00

TRANSPORTADOR/VOLUMES TRANSPORTADOS

RAZAO SOCIAL	FRETE P/ CONTA	C ANTT	PLACA VEICULO	UF	CNPJ CPF
COOPERATIVA DE TRANSPORTE	0 - Emitente		FZP0560 KMR6526	SP	59.303.123/0001-44

ENDERECO	MUNICIPIO	UF	INSCR ESTADUAL
R. PINTO FERRAZ 76	SAO CAETANO DO SUL	SP	636027934118

QUANTIDADE	ESPECIE	MARCA	NUMERACAO	PESO BRUTO	PESO LIQUIDO
30000	GRANEL			25.512,000 KG	25.512,000 KG

DADOS DO PRODUTO SERVICO

COD	DESCR PROD	NCM SH	CST	CFOP	UNID	QUANT	V UNIT	V TOTAL	BC ICMS	V ICMS	V IPI	ALIQUOTA ICMS	ALIQUOTA IPI
01.000.109	OLEO DIESEL MARITIMO A	27101921	060	5656	L	30.000,000	3,1433	94.299,00	0,00	0,00	0,00	0,00	0,00

ONU 1202 OLEO DIESEL 3 III
ICMS retido na fonte conforme Conv ICMS 110/07 - BC R$ 98.550,00 - ICMS retido R$ 11.826,00
IPI não tributado ou alíquota zero cf. Decreto 7660/2011 do MF
Central BR 4002-2040 ou 0800 282 20 40. Caso não estejam anexos, ligue (21) 3876.5959
Tanque 1478 - Boletim Conf. [illegible]
Valor aproximado dos tributos Federais: R$ [illegible] Estaduais: R$ 11.826,00 Municipais: R$ 0,00

OBS: NÃO FOI RECEBIDO AMOSTRA ÓLEO

Raimundo Adalberto de Sousa Neto
1º OM - Chefe de Máquinas
NOc "ALPHA - CRUCIS"

NAVIO OCEANOGRÁFICO ALPHA CRUCIS
Instituto Oceanográfico - USP

CALCULO DO ISSQN

INSCR MUNIC	VALOR TOTAL DOS SERVICOS	BASE DE CALCULO DO ISSQN	VALOR DO ISSQN
	0,00	0,00	0,00

DADOS ADICIONAIS

INFORMACOES COMPLEMENTARES

[illegible] Motorista: DANILO MEDEIROS [illegible] 66724884 66724885 66724886 66724887 [illegible] Nº do lacre: 66724895 66724896 [illegible] - COMRJ-201[illegible] OC 1096496 [illegible] PORTO DE SANTOS ARMAZEM 7 9 [illegible] serviços associados para [illegible] - Numero de [illegible] Contrato de [illegible] Conta de Faturamento [illegible] Federais [illegible]

RESERVADO AO FISCO

Annex 3: Messages with URI regarding to the malfunctioning IES

From: **D Randolph Watts** randywatts@uri.edu
Subject: Re: News from SAMBA
Date: April 26, 2018 at 12:24 PM
To: Edmo Campos edmo@usp.br
Cc: Chris Meinen - NOAA Federal christopher.meinen@noaa.gov, Dan Holloway danholloway@uri.edu

DW

Dear Edmo and Chris,
I have read the emails and diagnostic info.

The new firmware removes a known weakness the we only discovered after your 2nd deployment.
Previously, if an unexpected "interrupt" came, it would
lock up the micro controller (CF1),
would avoid the deadman reset,
run down the system batts.
These symptoms are what you encountered for SN291 (in 2012-2016) and
now for SN290 (in 2016-2018).
They are bad (2 of 5 deployments), but rare (2 times in >10 instrument-years).

Hard to reproduce on the bench here, but definite and now-fixed firmware weaknesses.

I recommend:
1) Fix the ACS - use the ACS chip in the kit that we sent.
2) upload the newest CPIES firmware from DanH that ChrisM is forwarding to you.

Do this on both instruments SN 289 and 290. They are equally vulnerable to the rare interrupts
and to the ACS problem.

Sorry I was out of touch two days without a chance to respond.

Best wishes,
Randy

D. Randolph Watts randywatts@uri.edu
Professor of Oceanography - 215 South Ferry Road
University of Rhode Island
Narragansett, RI 02881 t: 401.874.6507 f:401.874.6728

On Tue, Apr 24, 2018 at 10:11 AM, Chris Meinen - NOAA Federal <christopher.meinen@noaa.gov> wrote:

> Hi Edmo,
>
> I am trying to get answers/information from URI for you. So far, none
> of the URI folks are answering their telephones. I will keep trying.
>
> Major question - were the CPIES collecting travel time and/or pressure
> data since October 2016? (I know telemetry was failing, but were they
> collecting data?)
>
> If your CPIES were not collecting useful travel time and pressure data,
> unless Pedro finds an obvious mistake in how your CPIES were setup on
> the deployment cruise in October 2016, my recommendation is for you to
> not redeploy your CPIES on this cruise.
>
> I will let you know if I learn more from URI.
>
> Cheers,
>
> Chris
>
> --
> ##
> Dr. Christopher Meinen
> NOAA/AOML/PhOD
> 4301 Rickenbacker Causeway
> Miami, FL 33149
>
> Email: Christopher.Meinen@noaa.gov
> Office Phone: (305)361-4355
> Office Fax: (305)361-4412
> ##

Annex 4: Example of Letter sent by the Ship's Captain on behalf of the participants

Olá, amigos e famílias dos participantes do Cruzeiro SAMBAR, realizado pelo NOc Alpha Crucis - USP.
Comunico, por parte dos participantes, que as atividades do cruzeiro transcorrem conforme o planejado e todos encontram-se bem. Até agora vimos operando em boas condições de tempo, o que facilita os trabalhos.
Devido a limitação no envio e recebimento de emails, envio esta mensagem de caráter geral. Solicito não respondê-la. Contudo - em caso de efetiva necessidade, cite, por favor, o nome do destinatário no assunto do email.

Dear friends and family of the scientific party aboard the R/V Alpha Crucis of the University of Sao Paulo.
This is the Captain, and I am writing on behalf of them, to give you an update on our status at sea.
We are facing good weather. All is going well and everyone is safe and having good results with their research.
Please, do not reply this email, unless needed. In that case, please, notify the name of the person to be contacted on email´s subject.

Atenciosamente / kind regards,

José Helvécio Moraes de Rezende
Comandante / Captain
NOc / RV Alpha-Crucis

Annex 5: Commands used for LADCP deployment

We detail next the commands used for LADCP deployment during SAM15/SAMBAR_A1:

a) wh300_dn.cmd

```
;==================================================
;  W H M A S T E R . C M D
;  RHS: June 15, 2009
;
;  modified for use with firmware v50.36
;  data collected in beam coordinates...
;
;  WH300kHz master/downlooker deployment script
;==================================================
; Changes from previous deployment scripts:
; (1) only commands that change defaults are included (EA,ESetc removed)
; (2) data collected in beam coordinates (allows better inspection of
;     raw data and 3-beam solutions if necessary)
; (3) staggered single-ping ensembles every 0.8/1.2 s (Andreas has seen
;     bottom-interference in WH300 data in Antarctic - seems unlikely for
;     Abaco, but does not lose us pings).
; (4) 20 8 m bins - for a range of 160 m.
;
; Ask for log file
$L
;
; Cruise header info...
;
$P                                      .
$P      AB1104 WBTS program. Abaco line: Apr-May 2011  .
$P                                      .
$P        WH MASTER 300kHz LADCP DEPLOYMENT SCRIPT     .
$P                                      .
;
;
;
$D3
;
; display ADCP system parameters
PS0
; display ADCP system options
```

```
OL
; Pause
$D2
; return to factory default settings
CR1
;
; rename recorder prefix to 'MASTR'
rnMASTR
;
; WATER MODE 15 (NO MORE 'L' COMMANDS)
WM15
;
; Flow control:
;       - automatic ensemble cycling (next ens when ready)
;       - automatic ping cycling (ping when ready)
;       - binary data output
;       - disable serial output
;       - enable data recorder
CF11101
$D2
; coordinate transformation:
;       - radial beam coordinates (2 bits)
;       - use pitch/roll (not used for beam coords?)
;       - no 3-beam solutions
;       - no bin mapping
EX00100
; Sensor source:
;       - manual speed of sound (EC)
;       - manual depth of transducer (ED = 0 [dm])
;       - measured heading (EH)
;       - measured pitch (EP)
;       - measured roll (ER)
;       - manual salinity (ES = 35 [psu])
;       - measured temperature (ET)
EZ0011101
;
$D2
;  - configure staggered ping-cycle
; ensembles per burst
TC2
; pings per ensemble
WP1
; time per burst
TB 00:00:01.20
; time per ensemble
TE 00:00:00.80
; time between pings
TP 00:00.00
$D2
; - configure no. of bins, length, blank
```

```
; number of bins
WN020
; bin length [cm]
WS0800
; blank after transmit [cm]
WF0000
$D2
; ambiguity velocity [cm]
WV250
; amplitude and correlation thresholds for bottom detection
LZ30,220
$D2
; master
SM1
; send pulse before each ensemble
SA011
; wait .5500 s after sending sync pulse
SW05500
; # of ensembles to wait before sending sync pulse
SI0
$D2
; keep params as user defaults (across power failures)
CK
; echo configuration
T?
L?
$D5
; Time at start pinging
TS?
; start Pinging
CS
; End Logfile
$L
```

b) wh300_dn_shallow.cmd

```
;==================================================
;   W H M A S T E R . C M D
;   RHS: June 15, 2009
;
;   modified for use with firmware v50.36
;   data collected in beam coordinates...
;
;   WH300kHz master/downlooker deployment script
;===================================================
; Changes from previous deployment scripts:
; (1) only commands that change defaults are included (EA,ESetc removed)
; (2) data collected in beam coordinates (allows better inspection of
;     raw data and 3-beam solutions if necessary)
```

```
; (3) staggered single-ping ensembles every 0.8/1.2 s (Andreas has seen
;     bottom-interference in WH300 data in Antarctic - seems unlikely for
;     Abaco, but does not lose us pings).
; (4) 20 8 m bins - for a range of 160 m.
;
; Ask for log file
$L
;
; Cruise header info...
;
$P                                              .
$P       AB1104 WBTS program. Abaco line: Apr-May 2011  .
$P                                              .
$P         WH MASTER 300kHz LADCP DEPLOYMENT SCRIPT    .
$P                                              .
;
;
;
$D3
;
; display ADCP system parameters
PS0
; display ADCP system options
OL
; Pause
$D2
; return to factory default settings
CR1
;
; rename recorder prefix to 'MASTR'
rnMASTR
;
; WATER MODE 15 (NO MORE 'L' COMMANDS)
WM15
;
; Flow control:
;       - automatic ensemble cycling (next ens when ready)
;       - automatic ping cycling (ping when ready)
;       - binary data output
;       - disable serial output
;       - enable data recorder
CF11101
$D2
; coordinate transformation:
;       - radial beam coordinates (2 bits)
;       - use pitch/roll (not used for beam coords?)
;       - no 3-beam solutions
;       - no bin mapping
EX00100
; Sensor source:
```

```
;       - manual speed of sound (EC)
;       - manual depth of transducer (ED = 0 [dm])
;       - measured heading (EH)
;       - measured pitch (EP)
;       - measured roll (ER)
;       - manual salinity (ES = 35 [psu])
;       - measured temperature (ET)
EZ0011101
;
$D2
;  - configure staggered ping-cycle
; ensembles per burst
TC2
; pings per ensemble
WP1
; time per burst
TB 00:00:01.20
; time per ensemble
TE 00:00:00.80
; time between pings
TP 00:00.00
$D2
; - configure no. of bins, length, blank
; number of bins
WN020
; bin length [cm]
WS0400
; blank after transmit [cm]
WF0000
$D2
; ambiguity velocity [cm]
WV250
; amplitude and correlation thresholds for bottom detection
LZ30,220
$D2
; master
SM1
; send pulse before each ensemble
SA011
; wait .5500 s after sending sync pulse
SW05500
; # of ensembles to wait before sending sync pulse
SI0
$D2
; keep params as user defaults (across power failures)
CK
; echo configuration
T?
L?
$D5
```

```
; Time at start pinging
TS?
; start Pinging
CS
; End Logfile
$L
```

References

- Thurnherr, A. M., How to Process LADCP Data With the LDEO Software (Versions IX.7 – IX.12), 2016

Daniel Valla & Harold Fenco, April 2018