surface ocean solas lower atmosphere study

Report for the year 2015 and future activities

SOLAS Brazil ***compiled by:Leticia C. da Cunha (Brazlian SOLAS Representative, Universidade do Estado do Rio de Janeiro), Frédéric K. Bonou (Universidade Federal de Pernambuco), Paulo Nobre (Istituto Nacional de Pesquisas Espaciais)***

Please note that this report has two parts!

Part 1: *reporting of activities in the period of January 2015 – December 2015*
Part 2: *reporting on planned activities for 2016 to 2018/19.*

The information provided will be used for reporting, fundraising, networking and strategic development. In particular, ***in 2016 SOLAS will develop its Implementation Plan, which will be largely based on the information from part 2 of the national reports, as well as input from international SOLAS initiatives and activities****. This info will be crucial in order to draft a realistic Implementation Plan representative of SOLAS, internationally.*

IMPORTANT*: May we remind you that this report should reflect the efforts of the SOLAS community in the* ***entire country*** *you are representing (all universities, institutes, lab, units, groups)!*

PART 1 - Activities from January 2015 to December 2015

1. Scientific highlight

1 – FORSA Cruise (Following Ocean Rings in the South Atlantic Ocean)

Commission FORSA – Following Ocean Rings in the South Atlantic was the name of the maiden cruise of RV Vital de Oliveira (H-39, Brazilian Navy, in partnership with Brazilian Ministry of Science, Technology and Innovation). The ship left Cape Town, South Africa, and sailed to Brazil, in June-July 2015. The multidisciplinary scientific crew had 18 scientists from five Brazilian institutions, and Prof. Moacyr Araujo (UFPE) was the Chief-Scientist.

The ship followed the known Agulhas Rings Corridor in the South Atlantic Ocean (Figure 1), and performed underway measurements using a Moving Vessel Profiler (CTD, LOPC, fluorimeter) each 60 nm, a GO “ferry-box” system for surface ocean and atmospheric pCO_2 measurements, eddy-covariance fluxes of heat momentum and CO_2 (micro meteorological tower installed at the ship's bow), XBTs and radiometers. Six chosen meso-scale structures, known as Agulhas Rings were sampled (oceanographic stations, including plankton sampling), and the results are now being processed at the respective laboratories.

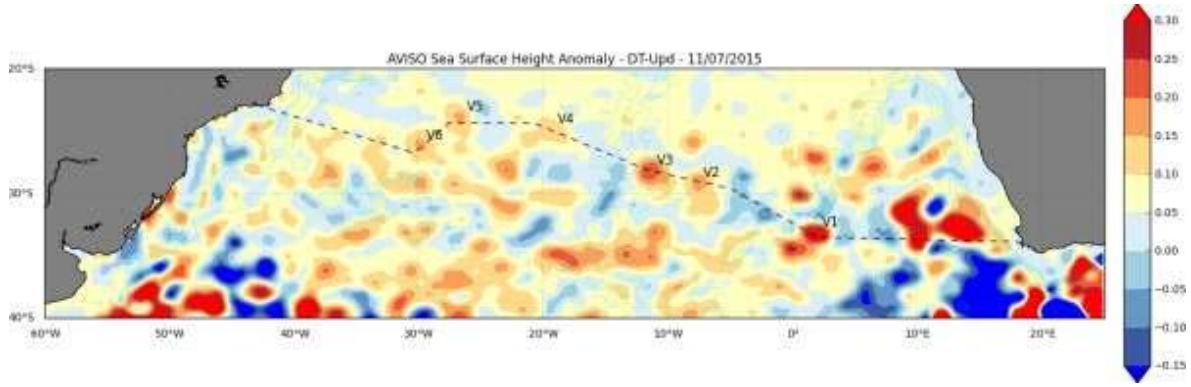

Figure 1 – RV Vital de Oliveira track during Commission FORSA (2015). The Rings are marked with V1 to V6 over sea surface height anomaly (in cm) from AVISO.

The FORSA Cruise was also the subject of an article at the "In Depth" Section in Science Magazine in August 2015:

Escobar, H.: Brazil looks to project scientific power on the Atlantic, Science (80-.)., 349(6248), 573, 2015.

2. Activities/main accomplishments in 2015 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, etc.)

*** Establishment of the Latin-American Ocean Acidification Network (LAOCA Network)**

On 14th and 15th December 2015, a group of 24 scientists from seven Latin-American countries, including Argentina, Brazil, Colombia, Ecuador, Peru, Mexico, and Chile meet at the city of Concepcion, Chile, for to establish the Latin-American Ocean Acidification Network (LAOCA Network). This regional workshop was co-funded by the International Atomic Energy Agency (IAEA) through the Ocean Acidification International Coordination Centre (OA-ICC), the Intergovernmental Oceanographic Commission (IOC-UNESCO), the Center for the Study of Multiple-Drivers on Marine Socio-Ecological Systems (MUSELS), and the Millennium Institute of Oceanography (IMO) from Chile. During two days the group of scientists discuss the strengths and weaknesses of each country in relation to ocean acidification' research, and also defining the mission and goals of LAOCA Network: (i) to synthesize the information about ocean acidification in L. America, (ii) implement long-term observations of carbonate chemistry in Latin-America, (iii) training of LAOCA members in the different action lines (e.g. observation, experimentation, and modeling), (iv) ensure good practices in order to enhance data quality, (v) to establish a regional node for the articulation and communication between local, regional, and global research programs, (vi) to determine and evaluate local and regional scenarios of Ocean Acidification for different types of marine ecosystems, (vii) to enhance scientists and student tudent exchange among institutions and LAOCA member countries, (viii) to design an outreach strategy for communicate the problematic of ocean acidification to society, (ix) to promote the development of cooperation projects between member countries of LAOCA, and (x) to promote the inclusion of Ocean Acidification on the political agenda of member countries.

Finally, scientists defined the LAOCA Executive Council, which will be co-chaired by Leticia C. da Cunha, (Universidade do Estado do Rio de Janeiro – UERJ, Brazil; Co-leader of the Brazilian Ocean Acidification Network), Nelson A. Lagos (Centro de Investigación e Innovación para el Cambio Climático (CiiCC), Universidad Santo Tomás, Chile; Member of the OA–ICC advisory board and SOLAS-IMBER WG in Ocean Acidification, SIOA) and Cristian A. Vargas (Universidad de Concepción, Chile; Member of the Executive Scientific Council at GOA-ON (Global Ocean Acidification Observing Network) and IOCCP (International Ocean Carbon Coordination Program). In addition, this executive council includes representatives from each country participating: Rodrigo Kerr (FURG, Brasil), Patricio Manríquez (CEAZA, Chile), Patricia Castillo-Briceño (ESPOL, Ecuador), Alberto Acosta (UTADEO, Colombia), Michelle Graco (IMARPE, Perú), Alejandro Bianchi (SHN, Argentina) and José Martín Hernández-Ayón (UABC, México). http://www.eula.cl/musels/latinoamerica-ya-tiene-su-red-de-acidificacion-del-ocaano-laoca-2015/

Figure 2 – Participants of the LAOCA Workshop, help in December 2015 in Concepción, Chile.

*** CMIP5 Model intercomparison:**

Brazilian Earth System Model (BESM) v. 2.3 has taken part into CMIP5 global climate change scenarios. The National Institute for Space Research (INPE) hosts the BESM group (Prof. P. Nobre and colleagues). BESM, at its newest version, will also participate to the coming CMIP6 round of coupled model intercomparisons.

*** Joint BrOA (Brazilian Research on Ocean Acidification) and SOLAS (Surface Ocean Lower Atmosphere Study) Workshop**

The joint workshop combined invited and selected talks, along with breakout group discussions corresponding to the main BrOA network and SOLAS topics. We realized that most of the original founders of BrOA were present and brought results of initiatives, experiments and collaborations. Also, that these groups have acquired or built, independently or in collaboration with each other, new equipments and facilities that are distributed in a wide range of the territory. We agreed on the need to push a common activity such as writing a position paper describing what we know, the groups involved in OA research, the infrastructure available, and the needs we identified to move forward on scientific aspects. It was an unanimous idea that we need a common ground on standardization of methods and data management. Besides, the need of using new technologies on sensors and platforms was also agreed. As the creation of a Latin American OA network was on discussion, we realized that many of our needs seemed to be common on the regional context. Thus, it was suggested that training workshops could be done, such as SOLAS Summer School, focusing on standardization of procedures and new technologies for CO_2 system measurements and that Latin American researchers could be a target public.

Workshop Highlights

* Two years after its implementation/start, BrOA network has now well established collaborations among its participants;
* BrOA laboratories have enhanced their analytical and experimental capacity;
* BrOA community will submit a statement paper to the special issue of ICES Journal of Marine Science where all current activities are compiled, and BROA's future goals and needs are presented;
* Workshop conveners will suggest SOLAS International Project Office to have its next Summer School focusing on CO2-system measurements, including new technologies for autonomous sensors;
* During the workshop, the participants identified the need to enhance communication about Ocean Acidification with policy makers, stakeholders, and general public;
* First concrete action to implement LAOCA Network – Latin American Ocean Acidification

Network.

Figure 3 - Participants of the Joint BrOA – SOLAS Workshop in Santos, Brazil (March 2015).

*** India / Brazil / South Africa (IBSA) Workshop on Earth System Modelling**, São Paulo, June 2015, Organised by P. Nobre (INPE).

CRUISES :

1 - PIRATA Brazil cruise over the western Tropical Atlantic between 19S-34W, 15N-38W; hydrography, pCO2, and atmospheric profiling done, on board RV Vital de Oliveira (Brazilian Navy), Oct. 2015..

2 – INCT Criosfera/GOAL/ACEX Cruise along the SW Atlantic Ocean, from Rio Grande to the Brazil/Malvinas Confluence ; hydrography, eddy-covariance measurements (micro-meteorology tower), meteorology, radiometer, on board Polar RV Almte. Maximiano (Brazilian Navy), Oct. 2015.

3 – NAUTILUS/INTERBIOTA cruise on the Antarctic Peninsula (Bransfield and Gerlache Straits) : hydrography and sample collection for chemical analysis (organic carbon, nutrients, total alkalinity, TCO2, pigments), on board Polar RV Almte. Maximiano (Brazilian Navy), February 2015.

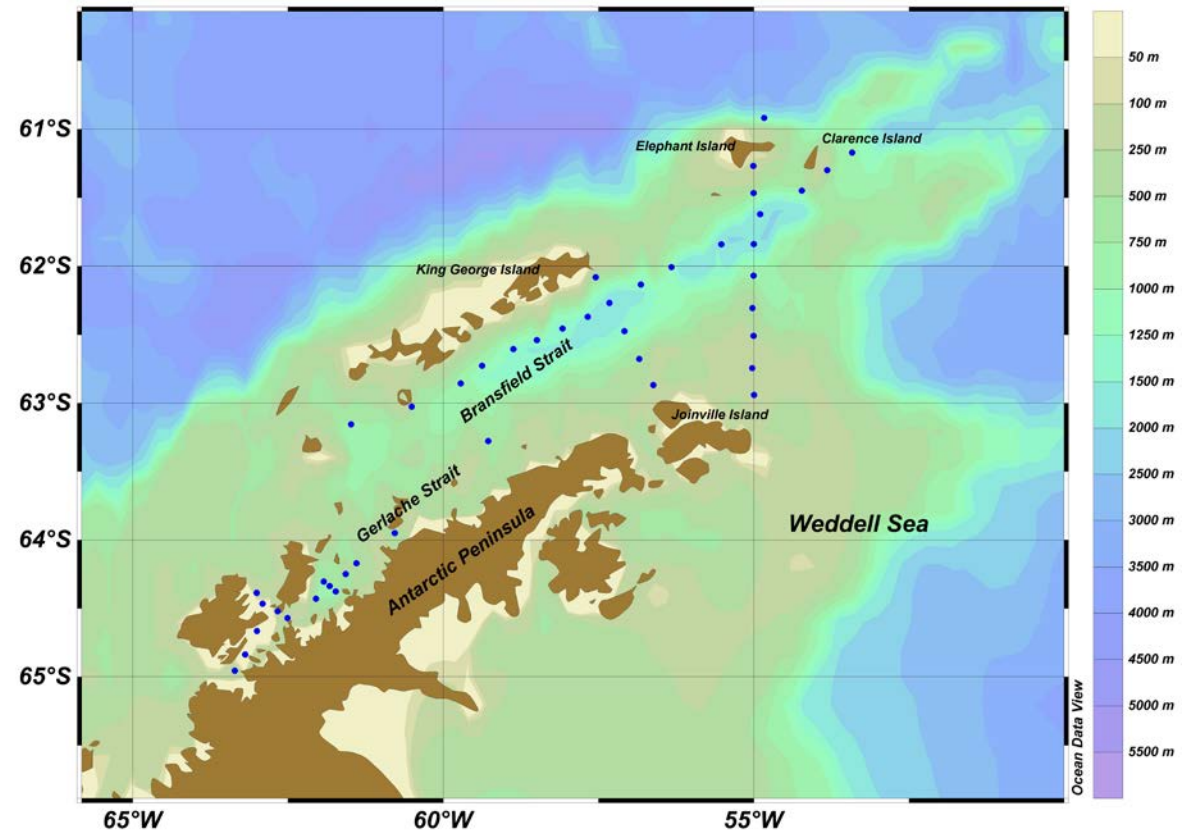

Figure 4 – NAUTILUS/INTERBIOTA 2015 Cruise - Occupied hydrographic stations at Bransfield and Gerlache Strait.

POSTER/ORAL PRESENTATIONS IN SOLAS RELEVANT EVENTS:

1. da Cunha, Leticia C., COELHO, C. A. W., SANTOS, P. P. W., KEIM, R. A., SOUZA, H. A. S., ARAUJO, M. P., Farias, C. O., HAMACHER, C. A snapshot of the marine CO2-system in three coastal ecosystems in SE Brazil In: 3rd PICES International Symposium: Effects of Climate Change on the World's Oceans, 2015, Santos. Book of Abstracts. PICES, 2015. v.1. p.177 - 177

2. da Cunha, Leticia C., SOUZA, H. A. S., ARAUJO, M. P., FARIAS, C. O., HAMACHER, C. Acidification through eutrophication- an example from an urban coastal ecosystem in SE Brazil In: SOLAS Open Science Conference 2015, Kiel.Abstracts, 2015. p.39 - 39

3. KERR, R., DA CUNHA, L. C., KIKUCHI, R. On the progress of the Brazilian Ocean Acidification Research Group: Two years of activities In: 3rd PICES International Symposium: Effects of Climate Change on the World's Oceans, 2015, Santos. Book of Abstracts. PICES, 2015. v.1. p.178 - 178

4. da Cunha, Leticia C., KERR, R., Araújo, M., NOBRE, P., SOUZA, R. B., PEZZI, L. The SW Atlantic Ocean: filling the observation gaps on ocean-atmosphere interactions In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

5. Santini, M. F., Souza, R. B. In situ measurements of the ocean--atmosphere interaction and land--atmosphere fluxes at Deception Island In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

6. Souza, R. B., Pezzi, L. P. A decade--long observational effort for s tudying ocean--atmosphere interaction processes in the Southwestern Atlantic Ocean. In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

7. Souza, R. B., Pezzi, L. P Mesoscale eddies of the Southwestern Atlantic Ocean and their impact on the atmosphere at the synoptic scale. In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

8. Pezzi, L. P, Souza, R. B., Acevedo, O., Miller, S. Atlantic Carbon and Fluxes Experiment (ACEx):
Results from the first cruise and perspectives. In: SOLAS Open Science Conference 2015, Kiel. SOLAS Open Science Conference Poster Abstracts. , 2015.

9. Soares, H. C., Nobre, P., Capistrano, V. B. The use of the TOPAZ as the marine biogeochemical component of the Brazilian Earth System Model (BESM). In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

10. Capistrano, V. B., Nilo, S., Reyes, P., Nobre, P. The new surface layer scheme of the Brazilian Earth System Model. In: SOLAS Open Science Conference 2015, Kiel. Abstracts. , 2015.

11. Nobre, P., Giarolla, E., Siqueira, L. Bottino, M., Malagutti, M., Capistrano, V. Equatorial Atlantic Ocean dynamics in a coupled ocean-atmosphere model simulation. In: WRCP/EMBRACE Workshop on CMIP5 Model Analysis and scientific plans for CMIP6, Dubrovnik, Croatia, 2015.

12. V. Capistrano, P. Reyes, S. Figueroa, E. Giarolla, C. Fonseca, M. Malagutti, M. Bapista, P. Nobre. Climate sensivity of the Brazilian Earth System Model, version 2.5. In: WRCP/EMBRACE Workshop on CMIP5 Model Analysis and scientific plans for CMIP6, Dubrovnik, Croatia, 2015.

13. Bonou, F. et al. “Variability of total alkalinity and total inorganic carbon in the western tropical Atlantic Ocean”. 3rd PICES International Symposium: Effects of Climate Change on the World’s Oceans, 2015, Santos. - Book of Abstracts. PICES, 2015

14. Bonou, F. et al “Western Tropical pCO2 maps derived from refression models”, Colloquium in Physical Oceanography and Applications: TACCOVAR : Tropical Atlantic Climate and Coastal Variability - October 5-1, 2015, Cotonou, Benin

15. EIDT, R. T. ; ORSELLI, I. B. M. ; Kerr, Rodrigo . Hydrography and CO2 partial pressure in the Gerlache Strait, Antarctica, during austral summer 2015. In: VIII Congreso Latinoamericano de Ciencia Antártica, 2015, Montevideo. Proceedings, 2015.

TRAINING:

*** Brazilian Earth System Model (BESM) Summer School**
July,27 until August, 7/2015 – Advanced Lectures Series on Coupled Ocean-Atmosphere Data Assimilation, with students from South Africa, India, and Brazil. INPE (National Institute for Space Research), Cachoeira Paulista, Brazil. http://spsgcm.ccst.inpe.br/index.html

*** 2015 LFA Summer Course :**
16 – 27 March 2015 – Course on atmospheric aerosols and clouds with introduction to process oriented modeling. Universidade de São Paulo & Universitet Stockholms. USP (Universidade de São Paulo), São Paulo, Brazil. http://lfa.if.usp.br/index.php/Events/2015SummerCourse

* - L. C. da Cunha is grateful to the SOLAS Open Science Conference and the OA-ICC at IAEA for the travel grant obtained to participate to the Conference in Kiel, Sep. 2015.

3. Top 5 publications in 2015 (only PUBLISHED articles) and if any weblinks to models, datasets, products, etc.

1 - Kerr, R., da Cunha, L. C., Kikuchi, R. K. P., Horta, P. A., et al. : The Western South Atlantic Ocean in a High-CO2 World: Current Measurement Capabilities and Perspectives, Environ. Manage., 57(3), 740–752, doi:10.1007/s00267-015-0630-x, 2016.

2 - Cotovicz Jr., L. C., Knoppers, B. A., Brandini, N., Costa Santos, S. J. and Abril, G.: A strong CO2 sink enhanced by eutrophication in a tropical coastal embayment (Guanabara Bay, Rio de Janeiro, Brazil), Biogeosciences, 12(20), 6125–6146, doi:10.5194/bg-12-6125-2015, 2015

3 - Giarolla, E., Siqueira, L. S. P., Bottino, M. J., Malagutti, M., *Capistrano*, V. B. and Nobre, P.:

Equatorial Atlantic Ocean dynamics in a coupled ocean–atmosphere model simulation, Ocean Dyn., 65(6), 831–843, doi:10.1007/s10236-015-0836-8, 2015

4 - Bonou, F. K., Noriega, C., Lefèvre, N. and Araujo, M.: Distribution of CO2 parameters in the Western Tropical Atlantic Ocean, Dynamics of the Atmosphere and the Oceans, 73, 47–60, doi:10.1016/j.dynatmoce.2015.12.001, 2016.

5 - Noriega, C., Araujo, M., Lefèvre, N., Montes, M. F., Gaspar, F. and Veleda, D.: Spatial and temporal variability of CO2 fluxes in tropical estuarine systems near areas of high population density in Brazil, Reg. Environ. Chang., 15(4), 619–630, doi:10.1007/s10113-014-0671-3, 2015.

PART 2 - Planned activities from 2016 to 2018/19

1. Planned major field studies and collaborative laboratory and modelling studies, national and international (incl. all information possible, dates, locations, teams, work, etc.)

- Bonou et al.(2016), A comparative study of Total Alkalinity and Total Dissolved Inorganic Carbon in the western and eastern boundaries.(To be submitted), Universidade Federal de Pernambuco (UFPE) → ***Future SOLAS Theme 1***

- Inclusion of the effects of river discharges, with tracers transport, into the Brazilian Earth System (BESM) climate simulations; inclusion of the full cycle of carbon (Land-Atmos-Ocean) into BESM version 2.5, Instituto Nacional de Pesquisas Espaciais (INPE), PI: Prof. Paulo Nobre → ***Future SOLAS Theme 1***

- 2017 PIRATA cruise in the Tropical Atlantic. PIRATA cruises are normally led by the team at the Dept. of Oceanography at UFPE. The date and the research vessel are yet to be confirmed. → ***Future SOLAS Themes 1, 2 and ; 5***

- Publication of the results of the first Brazilian intercalibration exercise on Total Alkalinity measurements in the SW Atlantic Ocean (MSc. Candidate Cíntia Coelho – Universidade do Estado do Rio de Janeiro – UERJ, supervisor Leticia C. da Cunha, with the participation of the Universidade Federal do Rio Grande – FURG, supervised by Rodrigo Kerr) → ***Future SOLAS Theme 3****;*

- 2016 EstARte-SUL Cruise: Biogeochemistry, Acidification and Anthropogenic Carbon at the SW Atlantic shelf break, on board RV Cruzeiro do Sul (Brazilian Navy). Date to be confirmed yet. PI: Prof. Rodrigo Kerr (FURG) → ***Future SOLAS Themes 1, 2, and 3***

- 2016 NAUTILUS/INTERBIOTA cruise to the Southern Ocean happened in Feb 2016: NAUTILUS project focuses on the processes that lead to the formation of Antarctic Bottom Water around the Antarctic Peninsula. Additionally, we are interested in the amounts of carbon and nutrients involved in the water mass transport in the region. INTERBIOTA is closely linked to NAUTILUS as it is an ecological approach of the marine food web in the region, from microbes to large marine mammals. PIs:Prof. Mauricio Mata (NAUTILUS, FURG) and Prof. Eduardo Secchi (INTERBIOTA, FURG) → ***FUTURE SOLAS Themes 1, 2, and 3***

2. Events like conferences, workshops, meetings, schools, capacity building etc. (incl. all information possible)

Please note this is a non-exhaustive list!

- ***4th International Symposium on the Ocean in a High-CO_2 World AND Global Ocean Acidification Observing Network (GOA-ON) Science Workshop**, in May 2016 in Hobart Australia → we foresee the participation of Br-SOLAS collaborators to the two events.*
- ***VII Brazilian Oceanography Congress (CBO2016')** – The congress will happen in November 2016 and counts with a special BrOA session and a joint BrOA/GEOTRACES Brazil short course for undergraduate students on using the available SOCAT 3.0 and GEOTRACES databases in Ocean Data View. Conference Web Page: http://www.cbo2016.org/*

3. Funded national and international projects / activities underway (if possible please list in order of importance and indicate to which part(s) of the SOLAS 2015-2025 science plan the activity topics relate – including the themes on 'SOLAS science and society' and 'Geoengineering')

Please note this is a non-exhaustive list of ongoing projects!

- **EstARte-SUL Cruise: Biogeochemistry, Acidification and Anthropogenic Carbon at the SW Atlantic shelf break:** funding through FAPERGS and CNPq, PI: Prof. Rodrigo Kerr (FURG), ***Future SOLAS Themes 1, 2 and 3***
- **INCT Criosfera and INCT AmbTrop:** Both are large consortia for Marine Sciences in Brazil, funded by CNPq. At present under negotiation for an extension of their duration. Links: http://www.ufrgs.br/inctcriosfera/ (Criosfera) and http://www.inctambtropic.org/ (Tropical Environments – AmbTrop), ***Future SOLAS Themes 1, 2,3, and 5***
- **PIRATA: Prediction and Research moored Array in the Tropical Atlantic**. PIRATA is a three-country project aiming at understanding tropical variability in the Atlantic Ocean (Brazil, France and USA). Br-PIRATA is funded through Ministry for Science, Technology and Innovation (MCTI) since 1997. http://pirata.ccst.inpe.br/ ***Future SOLAS Themes 1, 2, and 3***
- **SIMCOSTA: Coastal Monitoring System using autonomous buoys**. SIMCOSTA is funded through CNPq, Ministries for "Science, Technology and Innovation" and "Environment" and Rede Clima. Data available here: http://www.simcosta.furg.br . PI: Prof. Carlos Garcia (FURG). ***Future SOLAS Themes 1, 2, and Coastal Ecosystems***
- **Bilateral cooperation project UERJ – GEOMAR** (Kiel, Germany): focusing on establishing best practices for measuring CO2 system parameters over Brazilian shelf waters. The project foresees establishing in the future underway autonomous pCO2 measurements through VOS (voluntary observation ships). PIs: Prof. Leticia C. da Cunha (UERJ) and Dr. Tobias Steinhoff (GEOMAR), funding FAPERJ/DFG Call E_39/2014, Brazilian side yet to receive the money. ***Future SOLAS Themes 1 and Coastal Ecosystems***
- ***LTER/PELD Estuário da Lagoa dos Patos:*** a component of this LTER programme is now including monitoring CO2 system parameters in the Patos Lagoon Estuary in South Brazil. PI: Prof. Clarisse Odebrecht (FURG). http://www.peld.furg.br/ ***Future SOLAS Themes 1 and Coastal Ecosystems***
- **CAPES Ciências do Mar II – Guanabara Bay at Rio de Janeiro.** The project aims at understanding the exchanges between the inner shelf and the Guanabara Bay, one of the most populated coastal areas in Brazil. It has a strong component on biogeochemical fluxes (including phytoplankton ecology, nutrients and carbon), led by Prof. Gleyci Moser (UERJ). Funding by CAPES (Brazilian Federal Agency). ***Future SOLAS Theme "Coastal Ecosystems"***
- **Coastal Ecosystems in Rio de Janeiro.** Research grant from Rio de Janeiro State

Funding Agency FAPERJ to enable the regional development of marine CO2-system observations in coastal areas. PI: Prof. Leticia C. da Cunha. ***Future SOLAS Theme "Coastal Ecosystems"***

4. Plans / ideas for future projects, programmes, proposals national or international etc. (please precise to which funding agencies and a timing for submission is any)

Please note this is a non-exhaustive list!

1) Fernando de Noronha Experimental Observatory - FNEO: A proposal will be submitted to Brazilian Agency CNPq in order to start a scientific cooperation (Brazil-Cape Verde-Germany-France, led by *UFPE*) that aims to install a meteo-ocenographic observatory at the Fernando de Noronha Archipelago (tropical western Atlantic). The idea is to have in the western tropical Atlantic boundary a similar structure and sampling protocol used in the Cape Verde Oceanic Observatory.

2) Inclusion of the effects of river discharges, with tracers transport, into the Brazilian Earth System (BESM) climate simulations; inclusion of the ***full carbon cycle (Land-Atmos-Ocean)*** into BESM at INPE.

5. Engagements with other international projects, organisations, programmes etc.

Please note this is a non-exhaustive list!

1) CMIP6 is including the Brazilian Earth System Model (BESM) in its climate runs. PI: Prof. Paulo Nobre at INPE;

2) Brazilian Ocean Acidification Network (BrOA) is now actively linked to the **Latin American Ocean Acidification Network (LAOCA)**

3) Brazil is a partner in the **AtlantOS Consortium – H2020 – EU.** AtlantOS envisages improving and innovating the ocean observations in the Atlantic Ocean to to obtain an international, more sustainable, more efficient, more integrated, and fit-for-purpose system. The country is represented by the Ministry of Science, technology and Innovation (MCTI) https://www.atlantos-h2020.eu/about/

4) **MyScience-Cruise – an on-board training on the research vessel METEOR in 2016.** Two Brazilian students, Lívia Sancho (Universidade Federal do Rio de Janeiro – UFRJ) and Laís Lopes (FURG) participated to this training cruise. Support for "MyScience-Cruise" was provided by the Kiel Cluster of Excellence "The Future Ocean", "Partnership for Observation of the Global Oceans" (POGO), the EU H2020 project AtlantOS and École Normale Supérieure, Paris. http://www.oceanblogs.org/mysciencecruise/sample-page/

Comments

Although there are quite a few important research projects relevant to SOLAS science in Brazil at present, there is a big question mark concerning the scientific achievements for this year (2016) and at least for the coming 2-3 years, as a result of the severe economic crisis in the country.