



## *2<sup>nd</sup> Report of the Brazilian Ocean Acidification Research Group*

*based on the discussions occurred during the 3<sup>rd</sup> Brazilian Workshop on  
Climate Changes in Coastal Zones, held in Florianopolis (SC, Brazil) in  
December 2013.*

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## Executive Summary:

The *Brazilian Ocean Acidification Research Group* (BrOA; [www.broa.furg.br](http://www.broa.furg.br)) was created in December 2012. The first year (Dec. 2012 – Dec. 2013) of BrOA activities was marked by the network implementation. During this time, the group was recognized as a research network by the CNPq, and its researchers have been identified, as an action of the activities of the workshop "*Studying Ocean Acidification and its Effects on Marine Ecosystems*" (Dec. 4-6, 2012, Cananéia, Brazil). Also, we have identified the main Brazilian research groups and researchers working with Ocean Acidification (OA) issues and other biogeochemical subjects directly related to OA, which resulted in the identification of five main research topics, as follows: (i) **marine biogeochemistry (coastal and open ocean areas)**, (ii) **response of marine organisms to OA effects (bio-assays)**, (iii) **paleoceanography and proxies of past ocean acidification events and carbonate system**, (iv) **biogeochemistry and ecosystem modeling**, and (v) **physical and biogeochemical processes controlling air-sea CO<sub>2</sub> fluxes**.

To present date, BrOA network is composed of thirty-three (33) researchers from eight (8) Institutions of Higher Education, distributed into twelve (12) associated laboratories in Brazil. BrOA was formally presented to the Brazilian scientific community in December 2013 in Florianópolis, during the *3<sup>rd</sup> Brazilian Workshop on Climate Changes in Coastal Zones*. During this meeting the network activities in its first year were presented by Prof. Rodrigo Kerr, and after a round-table discussion the following points have been identified to guide BrOA's activities in the following years (2014-2019):

- ❖ Commitment to measure the carbonate system parameters in accordance with the best practices guidelines used by the international community;
- ❖ Measured carbonate system parameters should consider the ecosystem and the dynamics of the region, being recommended at least two of them;
- ❖ Strengthening the relationship with other networks that have actions of long-term measurements, thus better integrating sampling efforts;
- ❖ Currently Long Term Ecological Research Program (PELD) and/or REBENTOS ([www.rebentos.org](http://www.rebentos.org)) national networks have strategic sampling areas that are of OA significance and/or vulnerability (e.g. social, economy, food.);
- ❖ Dividing BrOA into regional committees (strengthen and integrate the network actions regionally);
- ❖ It is imperative that the monitoring of the carbonate system parameters start now, to ensure that in long-term period scientists will be able to infer and to identify aspects related with OA along the Brazilian waters.

The following points should guide BrOA scientists individually on the development of their research in the next five years (2014-2019):

- ❖ Focus in adapting the present laboratories regarding infrastructure and equipment related to OA analysis;

- ❖ Participation of all BrOA network laboratories to a national intercalibration of chemical analysis – this item will be receiving special attention by BrOA leaders, who will be organizing this exercise;
- ❖ Encourage early career scientists and young students to perform and investigate OA questions and responses to the ecosystems (The members should take advantage of Science without Borders opportunities, POGO and SCOR fellowships, Summer Schools, etc.);
- ❖ National and international collaborations between the members are recommended to increase scientific cooperation, students exchanges and BrOA expansion;
- ❖ New and future projects (and also results and manuscripts originated from them) regarding OA are recommended to be included in the BrOA webpage, which will be facilitating a national map of Brazil activities regarding OA;
- ❖ Regular meetings should happen with a certain periodicity in order to evaluate the progress and direct the actions of the BrOA network;
- ❖ The best practice methods should be adopted by all members to allow that the results (biogeochemical, bio-essays, experiments, etc.) obtained is comparable with other studies already underway;
- ❖ The BrOA network needs an oceanographic database, freely accessible to scientists, where the individual sets of data should be referenced using the international system "D.O.I. – digital object identifier", allowing the source to be quoted in scientific paper. BrOA leaders will make an attempt to contact PANGAEA (Germany, [www.pangaea.de](http://www.pangaea.de)) and study the possibilities for such action.

## 1. Background and Introduction

The *Brazilian Ocean Acidification Research Group* (BrOA; [www.broa.furg.br](http://www.broa.furg.br)) was created in December 2012, as an action of the activities of the workshop "*Studying Ocean Acidification and its Effects on Marine Ecosystems*" (Dec. 4-6, 2012, Cananéia, Brazil), which was organized by the International Geosphere-Biosphere Programme (IGBP), University of São Paulo (USP), Brazilian Council of Scientific Research and Development (CNPq) and Brazil's National Institute for Space Research (INPE). The 1<sup>st</sup>BrOA Report that resulted from this meeting is available through the link <http://joomla.furg.br/broa/images/doc/BROA.pdf> (only in Portuguese).

The first year of BrOA activities (Dec. 2012 – Dec. 2013) was marked by the network implementation. We have identified the main Brazilian research groups and researchers working with Ocean Acidification (OA) issues and other biogeochemical subjects directly related to OA.

The BrOA operates in distinct environments along the Brazilian coast, including coastal, estuarine and oceanic open waters ecosystems. Five research lines were defined to govern the actions of the BrOA network, as follows:

(i) ***marine biogeochemistry (coastal and open ocean areas)*** – this research line aims to monitor the major biogeochemical parameters in coastal and estuarine ecosystems (lagoons, mangroves), and open ocean areas. The objective is identify changes in environmental properties due to anthropogenic interference and the excess of CO<sub>2</sub> being human-released into the atmosphere.

(ii) ***response of marine organisms to OA effects (bio-assays)***–this research line aims to determine the impacts and effects of ocean acidification and seawater properties (e.g., temperature, salinity, dissolved oxygen) in trophic dynamics and in the metabolism of organisms and marine communities, including phytoplankton, zooplankton, reefs and benthos of consolidated and non-consolidated sediments.

(iii) ***paleoceanography and proxies of past ocean acidification events and carbonate system*** – this research line aims to assess the application of carbonate proxies in reconstitution of the past marine carbonate system, enabling the understanding of the effects of changes in atmospheric CO<sub>2</sub> in the ocean from previous events of high atmospheric concentration.

(iv) ***biogeochemistry and ecosystem modeling*** – this research line aims to simulate the biogeochemical parameters from ocean regional models runs for studies of ocean acidification and its impacts on marine biota and fish resources.

(v) **physical and biogeochemical processes controlling air-seaCO<sub>2</sub> fluxes** – this research line aims to determine and model net flux of carbon dioxide into the air-sea interface of coastal environments, estuarine and oceanic regime, as well as using ocean color remote sensing to determine the carbonate system in large spatial scale.

The BrOA network featured in 2013 with thirty-three (33) researchers from eight (8) Institutions of Higher Education, distributed into twelve (12) associated laboratories (Fig. 1).



**Figure 1.** Geographical distribution of the main Brazilian Institutions (**Rio Grande do Sul State:** Federal University of Rio Grande – FURG; **São Paulo State:** University of Sao Paulo – USP; **Rio de Janeiro State:** Fluminense Federal University – UFF, Federal University of Rio de Janeiro – UFRJ and State University of Rio de Janeiro – UERJ; **Bahia State:** Bahia Federal University – UFFBa and State University of Santa Cruz – UESC; **Pernambuco State:** Federal University of Pernambuco – UFPe) that participate through BrOA Network and develop scientific studies related to OA.

Before the formal presentation of BrOA to the Brazilian scientific community, which happened in Florianópolis during the *3<sup>rd</sup> Brazilian Workshop on Climate Changes in Coastal Zones*, some punctual actions to support the group were executed by BrOA leaders during 2013. The BrOA initial activities were national and internationally presented in related scientific meetings and conferences, from which we emphasize the ***Global Ocean Acidification – Observing Networks (GOA-ON) Workshop***, and the ***Brazil-France Meeting***, held in St. Andrews (UK) and Búzios (Brazil), respectively. All abstracts, posters, lectures and talks from the first year of BrOA activities are available at [www.broa.furg.br](http://www.broa.furg.br).

This report aims to establish a guide to direct the medium-term actions and highlight specific points that need the BrOA network attention in the near future. Section 2 highlights the main ideas/points presented by the invited researchers to identify the OA state-of-the-art held in Brazil. Section 3 summarizes the main community inputs raised from the discussions, which is followed by Section 4 that establish the BrOA medium-term goals (3-5 years).

A long-term guideline is expected to result from the *1<sup>st</sup> BrOA Workshop* that will occur in Santos (Brazil) in March 2015 through the meeting occurring into 3<sup>rd</sup> International Symposium “*Effects of Climate Change in the World’s Ocean*” ([http://www.pices.int/meetings/international\\_symposia/2015/2015-Climate-Change/scope.aspx](http://www.pices.int/meetings/international_symposia/2015/2015-Climate-Change/scope.aspx)). Thus, the community will have tools to evaluate the progress and the opportunity to better integrate BrOA activities with national/international OA programs and networks from several regions of the world.

## 2. Round-Table Composition and Goals

During the Florianópolis meeting (Dec 2013), the round-table was entitled “*The inclusion of Brazilian research in the context of Ocean Acidification – Identifying areas sensitive to their purpose and priorities*” and composed by an invited international speaker from NOAA (USA), Dr. Libby Jewett (Director of the NOAA OA Program and GOA-ON Co-Chair), and the Brazilian researchers: Dr. Rodrigo Kerr (FURG; Mediator), Dr. Leticia C. da Cunha (UERJ), Dr. Rosane G. Ito (FURG), Dr. Moacyr C. Araujo (UFPe) and Dr. Ruy Kikuchi (UFBA).

Dr. Libby Jewett started the section giving a talk introducing a brief **overview of the science of OA**, also covering the US research and GOA-ON (*Ocean Acidification Research: Global to Local*). The **first year of BrOA activities** was further presented by Dr. Rodrigo Kerr (*Activities of the Brazilian Ocean Acidification Research Group*), followed by presentations regarding distinct environments along the Brazilian coast: Dr. Leticia Cunha was responsible to characterize **coastal and estuarine regions** (*Role of the Brazilian coastal zone in the air-sea CO<sub>2</sub> flows and possible effects of acidification*), **tropical zones** were described by Dr. Moacyr Araújo

(PIRATA and INCT - AmbTropic: new observation networks of CO<sub>2</sub> in the tropical Atlantic), **subtropical and polar zones** were illustrated by Dr. Rosane Ito (*State of the art of Brazilian studies on acidification in the Atlantic and Southern Southwest*), and **biological impacts in sensitivity areas** shown by Dr. Ruy Kikuchi (*Trends in investigations of the impacts of ocean acidification on coral growth and coralline algae*). All slides presentations are available at the BrOA website.

The aims of this round-table were: (i) to identify the OA state-of-the-art in Brazil, (ii) to map sensitive areas to the effects of OA in the Brazilian seas and ecosystems, (iii) to identify monitoring networks already deployed that could collaborate with BrOA to start the monitoring of the biogeochemical parameters needed for OA studies, and (iv) to better integrate the Brazilian OA activities with the GOA-ON ([www.goa-on.org](http://www.goa-on.org)).

To achieve those goals the speakers have identified the main Brazilian scientific projects in development and to be implemented that may contribute to the OA studies, and areas/ecosystems of the Brazilian territorial waters that are particularly sensitive to the OA effects.

### 3. Workshop Participation and Community Input

The following points were raised from the round-table discussion and were considered/included into the short- and medium-terms issues (see Section 4) that will guide the BrOA network activities in the following years (2014-2019):

- ❖ BrOA community is committed to measure the carbonate system parameters (total alkalinity, *f*CO<sub>2</sub>, pH, and dissolved total inorganic carbon) in accordance with the best practices guidelines used by the international community (Dickson et al., 2007 – *Guide to Best Practices for Ocean CO<sub>2</sub> Measurements* & Riebesell et al., 2010 – *Guide to best practices for ocean acidification research and data reporting*);
- ❖ The parameters measured should consider the ecosystem and the dynamics of the region, and it is not necessarily to measure all parameters (it is recommended at least two of them);
- ❖ Whenever possible the BrOA community will be strengthening its relationship with other national networks that have actions of long-term measurements, thus better integrating sampling efforts;
- ❖ Most of the current identified networks (e.g. PELD, REBENTOS) have strategic sampling areas that are of OA significance and/or vulnerability (e.g., social, economy, food.) to long-term OA;
- ❖ BrOA should be divided into regional committees to better integrate and strengthen the relationships of BrOA activities with other networks;

- ❖ It is imperative that the monitoring of the carbonate system parameters start now, independent of the platform used (chemical sensors at buoys, fixed sampling points), to be possible in a long-term period to infer and to identify aspects related with OA along the Brazilian coastline and ocean waters.

#### 4. BrOA Medium-term goals

The following points should guide the BrOA researchers on the development of their research in the next five years (2014-2019):

- ❖ The BrOA research should focus in adapting their laboratories regarding infrastructure and equipment related to OA analysis;
- ❖ It is needed that all laboratories of the BrOA network participate through a national intercalibration of chemical analysis – this item will be receiving special attention by BrOA leaders, who will be organizing this exercise;
- ❖ Early career scientists and young students should be encourage to perform and investigate OA questions and responses to the ecosystems (Capacity building is imperative to have appropriate leaders in the near future. The members should take advantage of Science without Borders opportunities, POGO and SCOR fellowships, Summer Schools, etc.);
- ❖ National and international collaborations between the members are recommended to increase scientific cooperation, students exchanges and BrOA expansion;
- ❖ New and future projects (and also results and manuscripts originated from them) regarding OA are recommended to be included in the BrOA webpage, which will be facilitating a national map of Brazil activities regarding OA;
- ❖ Regular meetings should happen with a certain periodicity in order to evaluate the progress and direct the actions of the BrOA network – the 1<sup>st</sup> BrOA Workshop will be occurring in March 2015, led by Dr. Rodrigo Kerr (FURG), Dr. Leticia C. da Cunha (UERJ), Dr. Ruy Kikuchi (UFBa) and Dr. Paulo Sumida (USP). It is expected that the general content of presentations, along with summations of general and breakout group discussion will be included in the Third Report of the BrOA. In addition it is anticipated that a journal manuscript assessing the state of the art of ocean acidification studies in South America will be prepared;
- ❖ The best practice methods should be adopted by all members to allow that the results (biogeochemical, bio-essays, experiments, etc.) obtained are comparable with other studies already underway;
- ❖ The BrOA network needs to have an oceanographic database (such as the German PANGAEA), freely accessible to scientists, where the individual sets of data should be referenced using the international system "D.O.I. – digital object identifier", allowing the source to be quoted in scientific paper.