

PIRATA and INCT-AmbTropic: New CO₂ observing network in the tropical Atlantic

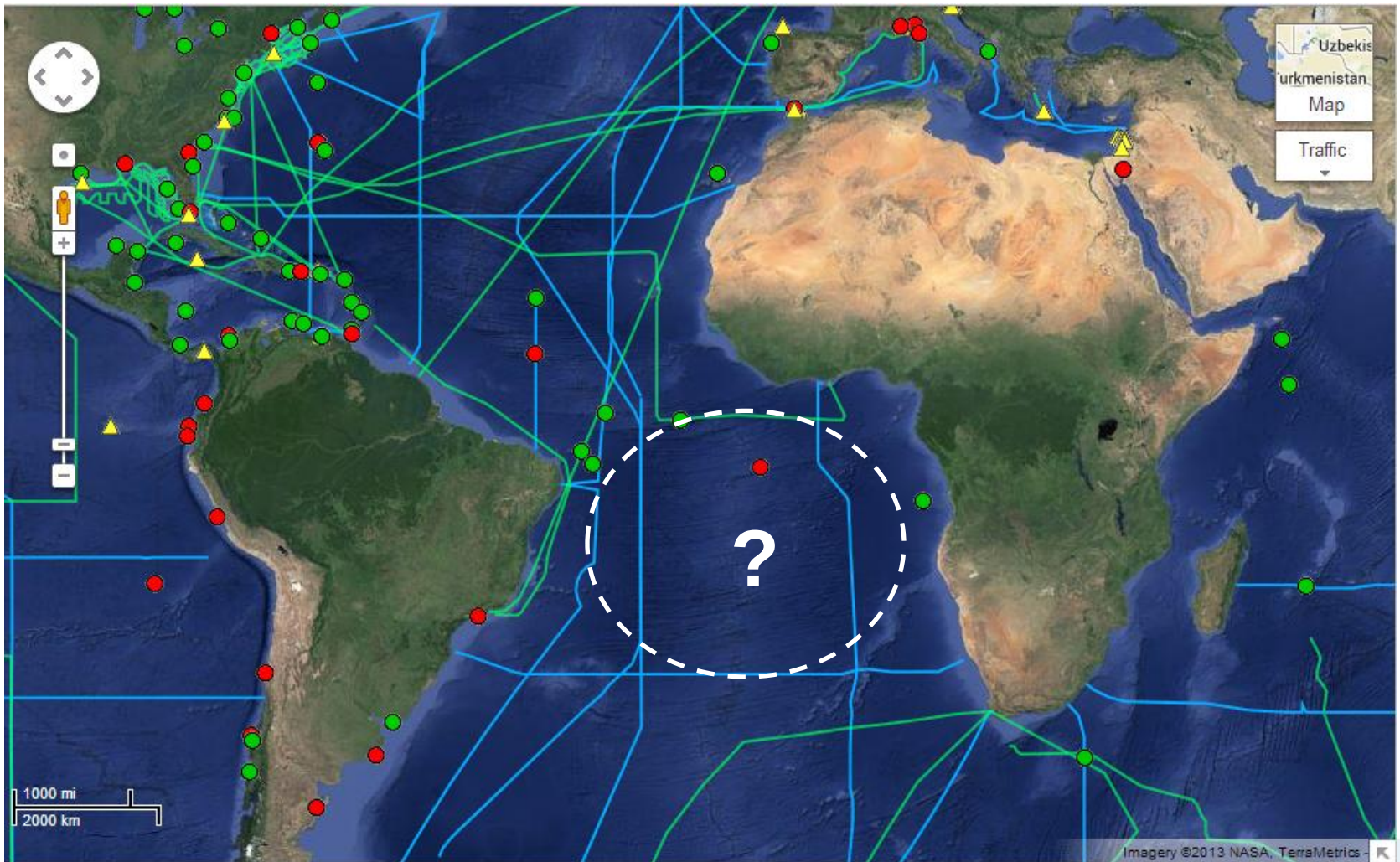
**M. Araujo(*) , N. Lefèvre, P. Nobre , C. Noriega,
L. Bruto, R. Araujo**

(*) moa@ufpe.br

**Centro de Estudos e Ensaio em Risco e Modelagem Ambiental - CEERMA
Departamento de Oceanografia – DOCEAN/UFPE**

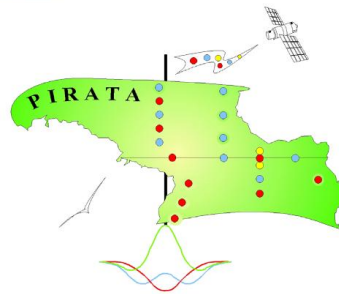
**III Workshop Brasileiro de Mudanças Climáticas em Zonas Costeiras
Florianópolis-SC, 10-12 Dez 2013**

GOA-ON



Outline

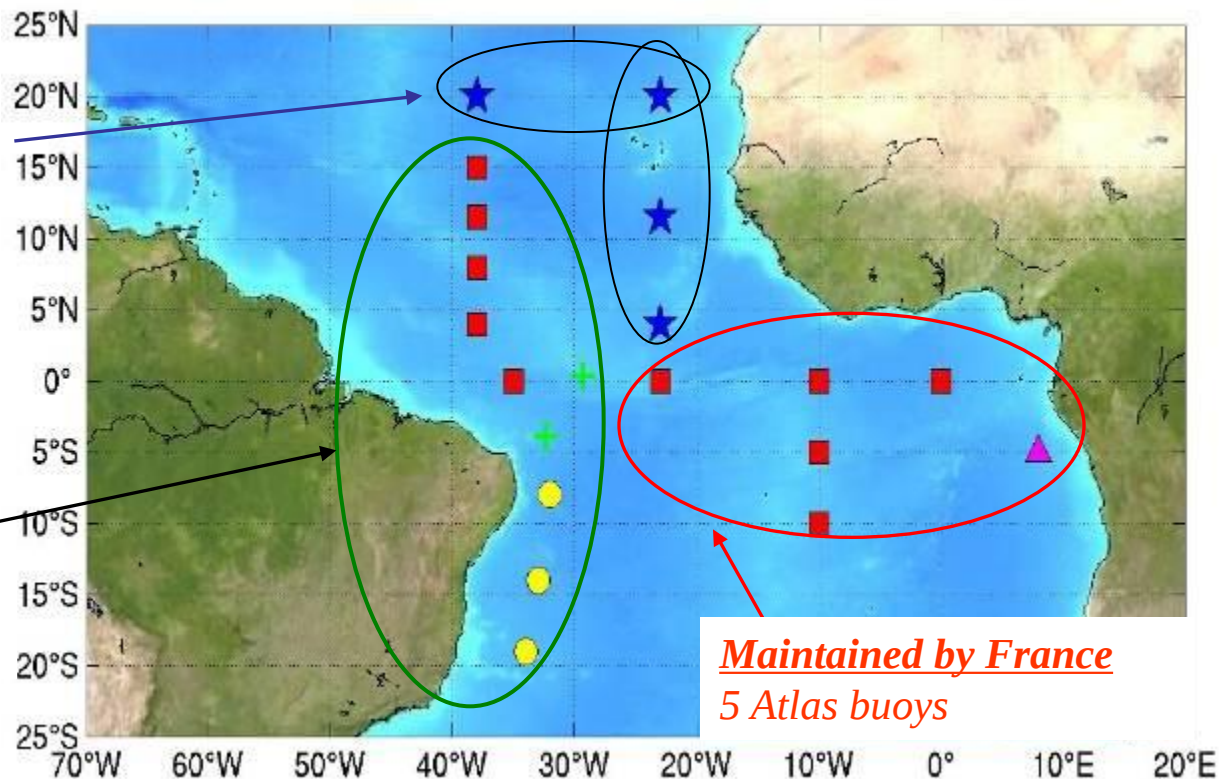
- **Prediction and Research Moored Array in the Tropical Atlantic - PIRATA (1998-...)**
- **National Institute on Science & Technology in Tropical Marine Environments - INCT-AmbTropic (2012-2017)**
WP3.2: Biogeochemical Cycles, CO₂ Fluxes and Acidification of the Tropical Atlantic
- **Associated Projects:**
 - CO2-Brazil (CNPq 403241/2012-0)
 - ARQ_MODEL II (CNPq 405350/2012-0)
 - MoU DOCEAN/UFPE - GEOMAR (Meteor M98/M106)
 - MoU DOCEAN/UFPE - IIM-CSIC (FICARAM 15)



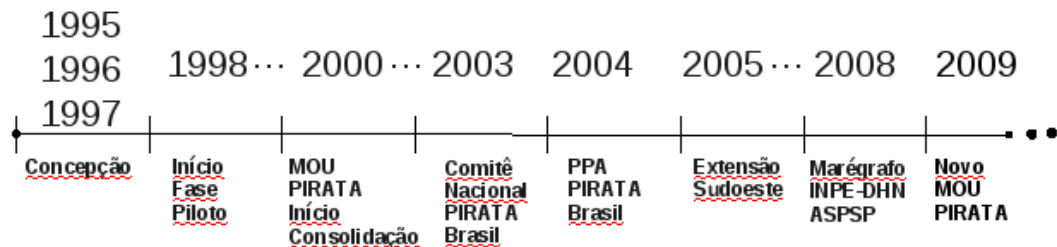
PIRATA

Maintained by USA:
4 Atlas buoys

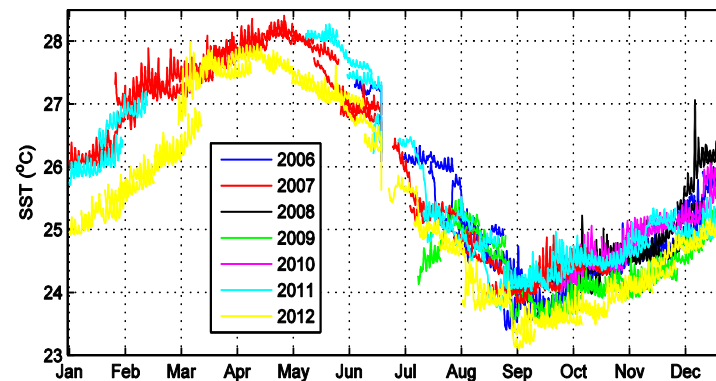
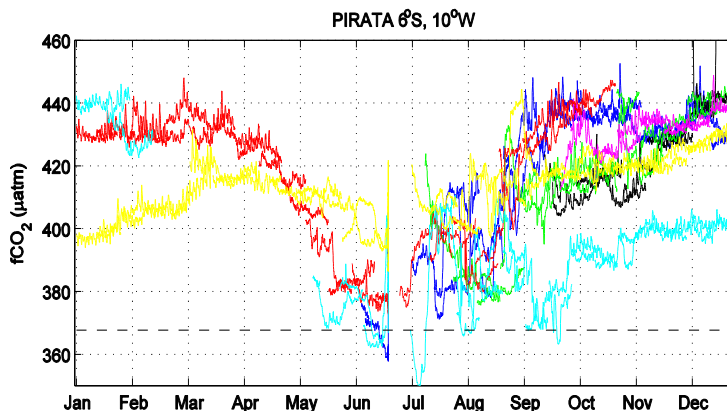
Maintained by Brazil:
8 Atlas buoys



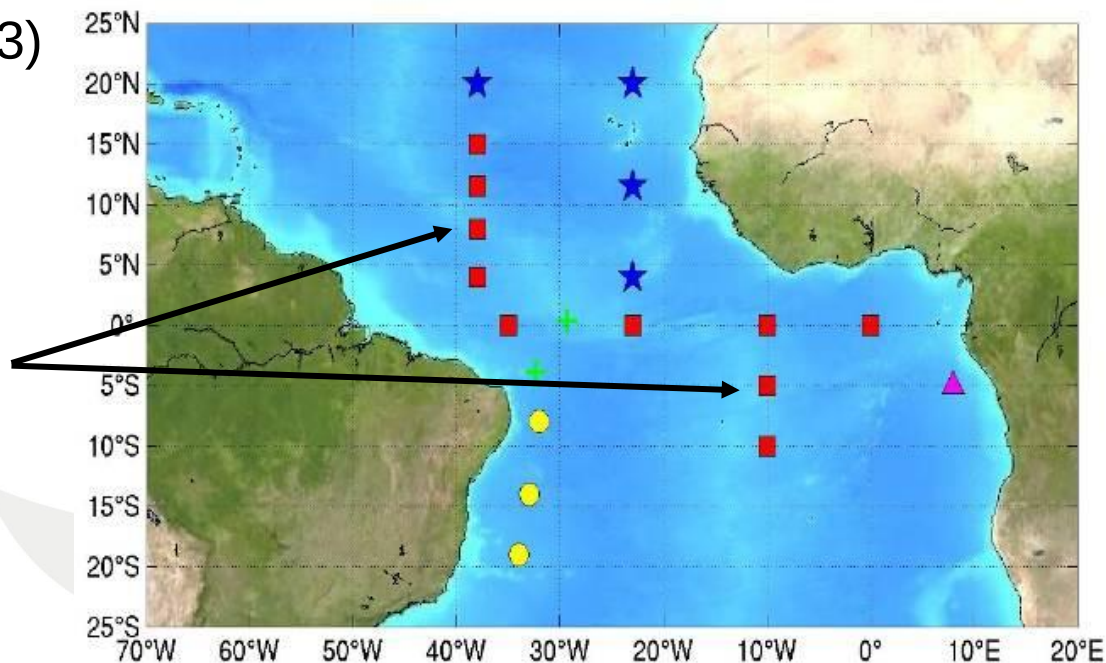
Maintained by France
5 Atlas buoys



6°S10°W (2006-2013)



8°N38°W (2008-2013)

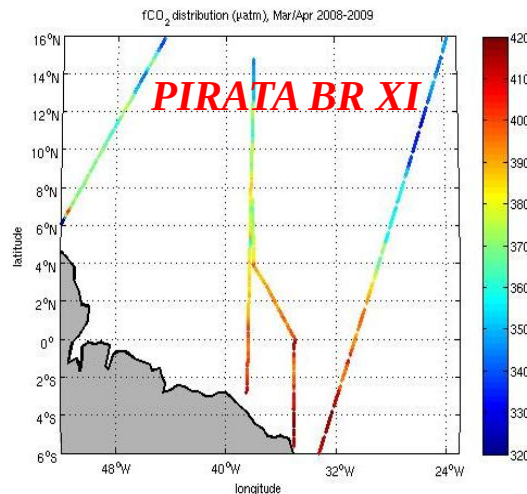


Medições contínuas u-fCO₂ PIRATA-BR

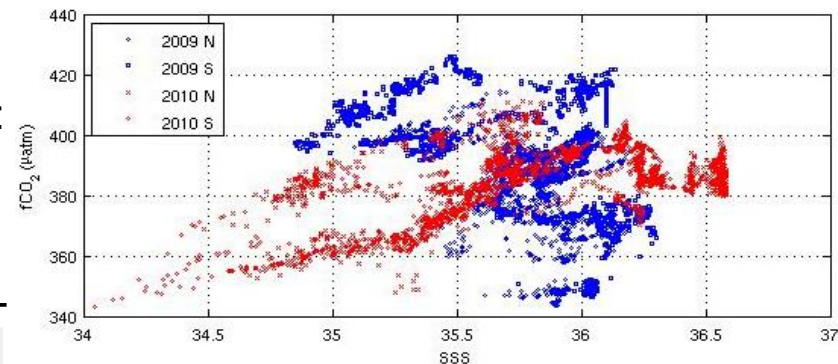
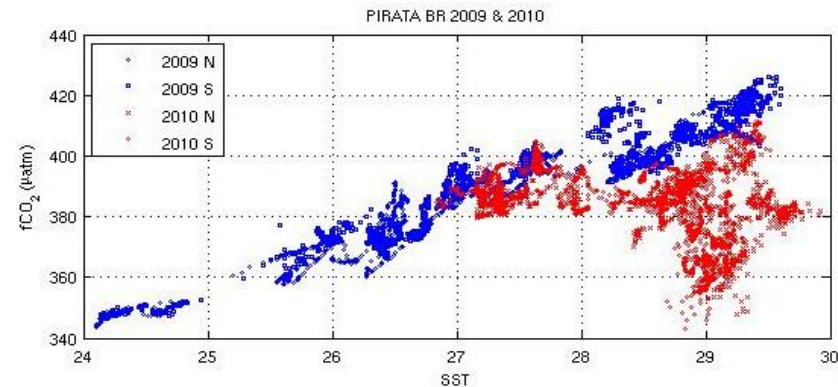
- Yearly sampling (DIC, TA) during the PIRATA BR cruises
- Underway fCO₂ PIRATA BR cruises along 38°W → **ITCZ + Amazon plume ?**



On board NOc. Antares
(July 2010)

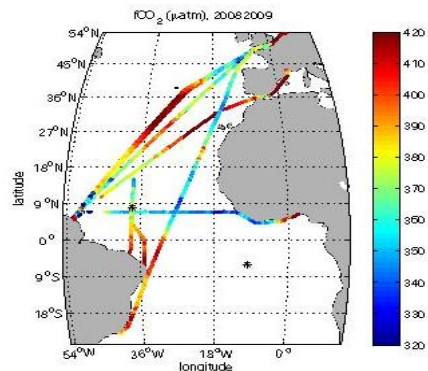


PIRATA BR 2009, 2010, 2011:
DIC, TA, fCO₂

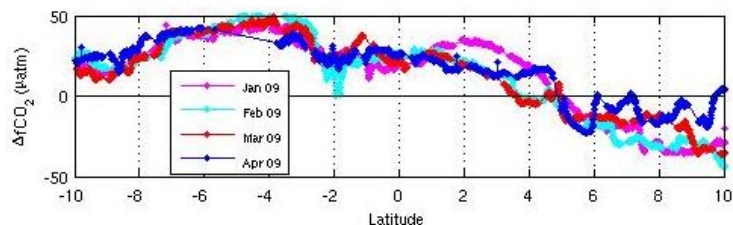
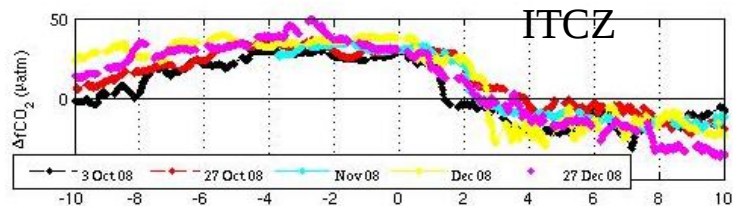
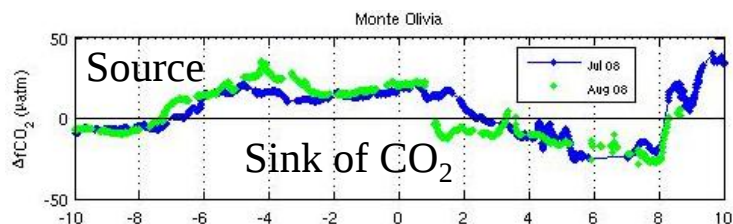


Mar-Apr 2009: fCO₂ strongly correlated with SST
Jul-Aug 2010: some correlation with SSS (ITCZ)

Medições contínuas u-CO₂ NOc. Antares



GO, Inc.



Jan. 2014- ...



July to December: sink of CO₂ associated with low salinity (ITCZ > 2°N);
January to April: sink of CO₂ due to winter cooling in the northern hemisphere.

Enhancement CO₂ Observation

Proposal 1 (P1):

1. Who (PI): Adrienne Sutton (PMEL/NOAA), May 2012.
2. Where: 03 reference buoys
10°S10°W: OceanSITE flux
0°23°W: OceanSITE flux
15°N38°W: OceanSITE flux
3. How much: US\$ 102,000/buoy (MAPCO2).
4. Who pay: Countries involved in the array (Brazil, France, and USA).

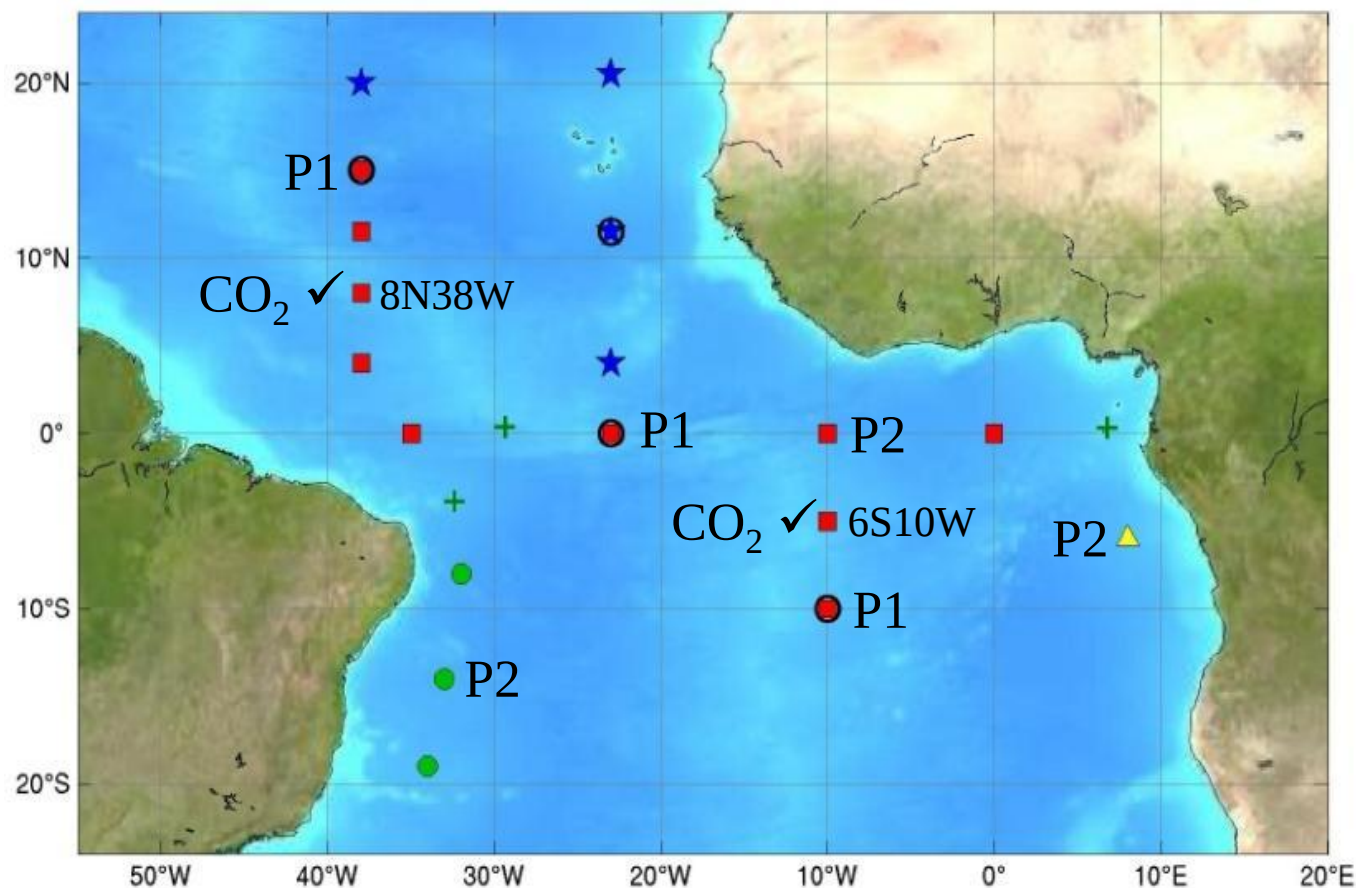
Enhancement CO₂ Observation

Proposal 2 (P2):

1. **Who (PI):** Moacyr Araujo (UFPE) and Nathalie Lefèvre (IRD), Jan. 2013.
2. **Where:** 03 PIRATA sites
 - 14°S32°W: close to the bifurcation of the SEC; is CO₂ increasing westward as suggested by the sampling of several sections in the equatorial Atlantic during the FOCAL cruises ?
 - 0°10°W: to monitor the equatorial upwelling/cold tongue and its impact on the CO₂ and O₂ variability.
 - 6°S8°E: close to the Congo River mouth to monitor the impact of the river outflow and coastal upwelling.
3. **How much:** US\$ 40,000/buoy (CARIOCA+O₂ Anderra).
4. **Who pay:** INCT-AmbTropic (**1 system for 14°S32°W**) + countries involved in the array (Brazil, France, and USA) for two others systems (0°10°W+ 6°S8°E).

Enhancement CO₂ Observation

Proposals 1 (P1) and 2 (P2)



Outline

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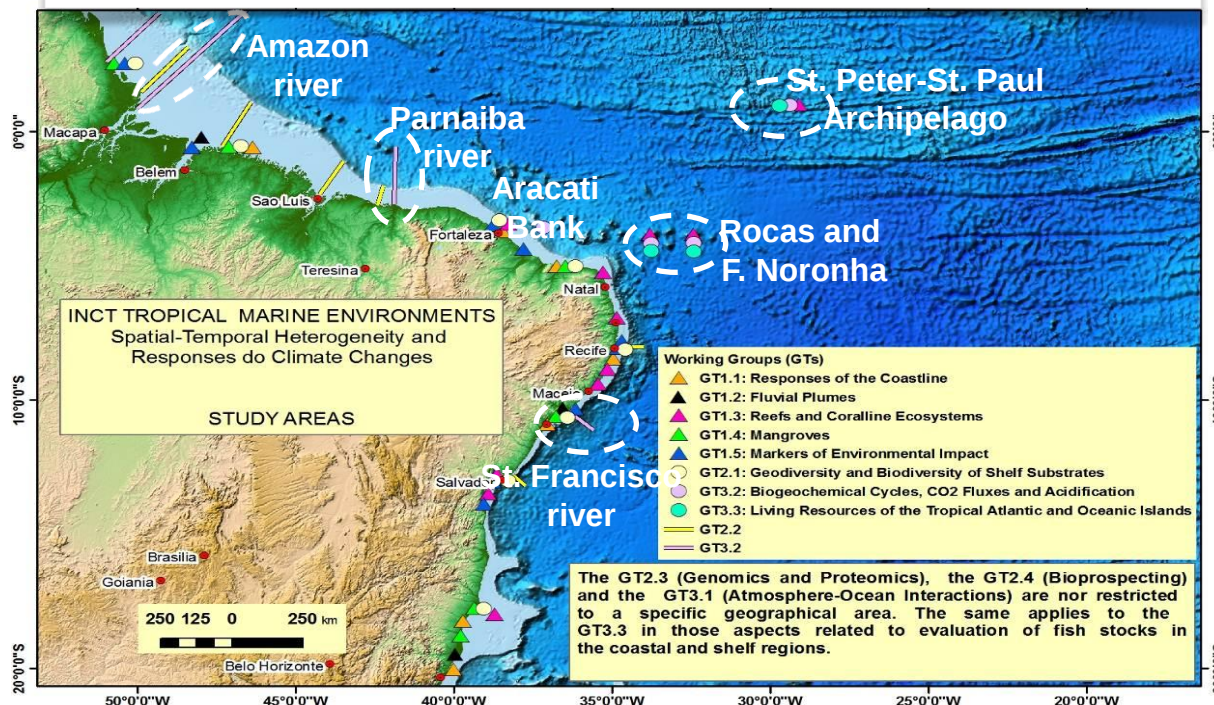
INCT-AmbTropic

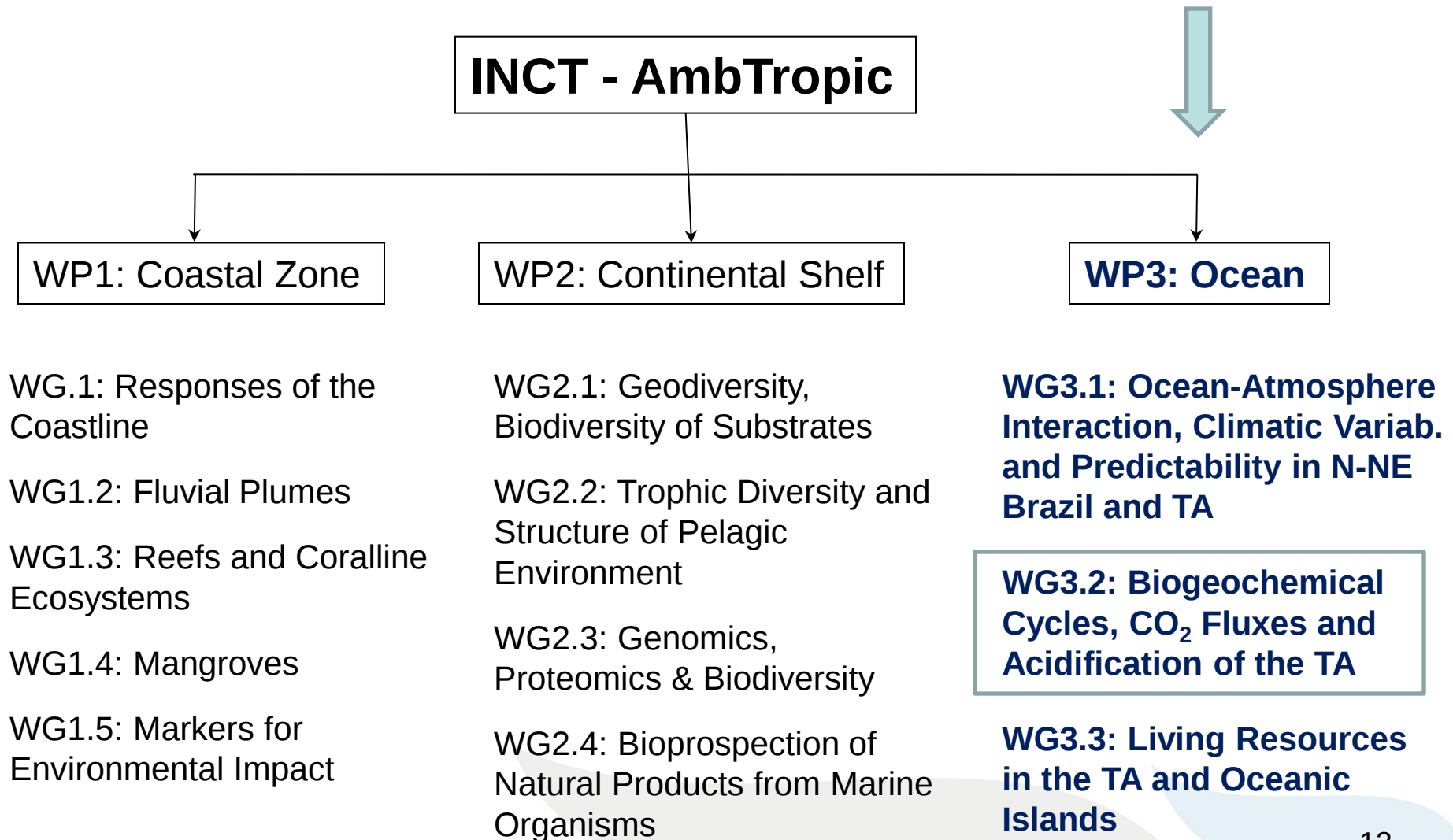
Main oceanographic centers in the N-NE Brazil (UFPE, UFBA, UFRN, UFPA, UFMA, UFRA, ...)

~ 50 scientists ...

~ 60 PhD students, ...

The central unifying theme of the INCT Tropical Marine Environments (**AmbTropic**) is the spatial-temporal heterogeneity of tropical marine environments and how this may determine the response patterns of these environments and their resilience to climate changes that will affect the North-Northeast of Brazil in this century.





INCT - AmbTropic

WP1: Coastal Zone

WG.1: Responses of the Coastline

WG1.2: Fluvial Plumes

WG1.3: Reefs and Coralline Ecosystems

WG1.4: Mangroves

WG1.5: Markers for Environmental Impact

WP2: Continental Shelf

WG2.1: Geodiversity, Biodiversity of Substrates

WG2.2: Trophic Diversity and Structure of Pelagic Environment

WG2.3: Genomics, Proteomics & Biodiversity

WG2.4: Bioprospection of Natural Products from Marine Organisms

WP3: Ocean

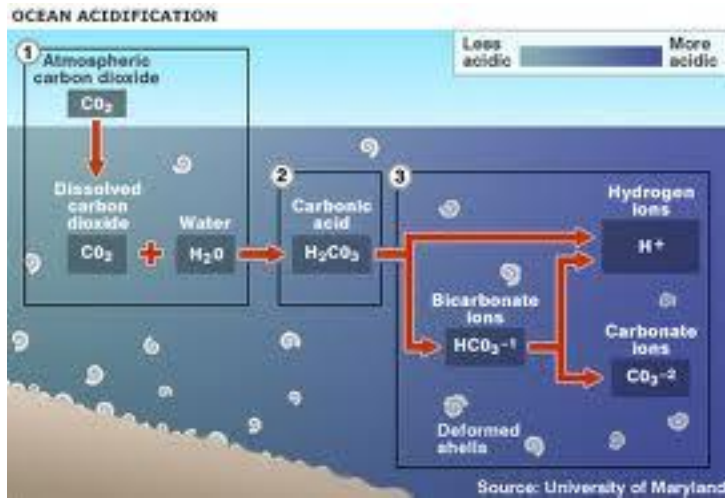
WG3.1: Ocean-Atmosphere Interaction, Climatic Variab. and Predictability in N-NE Brazil and TA

WG3.2: Biogeochemical Cycles, CO₂ Fluxes and Acidification of the TA

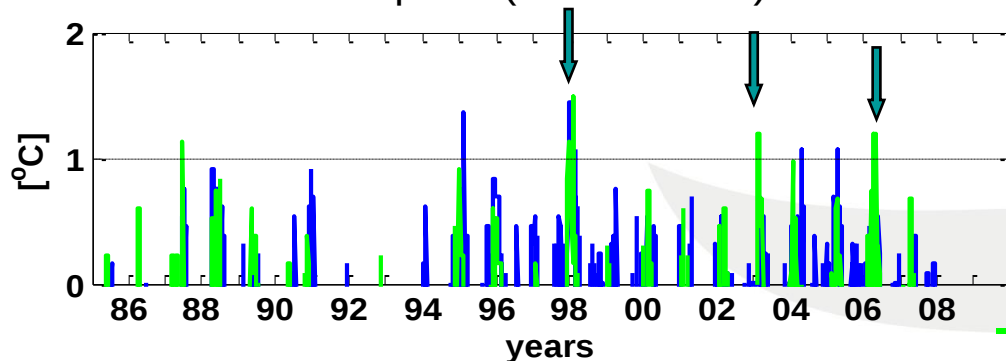


WG3.2: Biogeochemical Cycles, CO₂ Fluxes and Acidification of the TA

(ii) Coralline systems: Rocas, Fernando de Noronha, Abrolhos, ...



Hot spot = (SST – MMM)



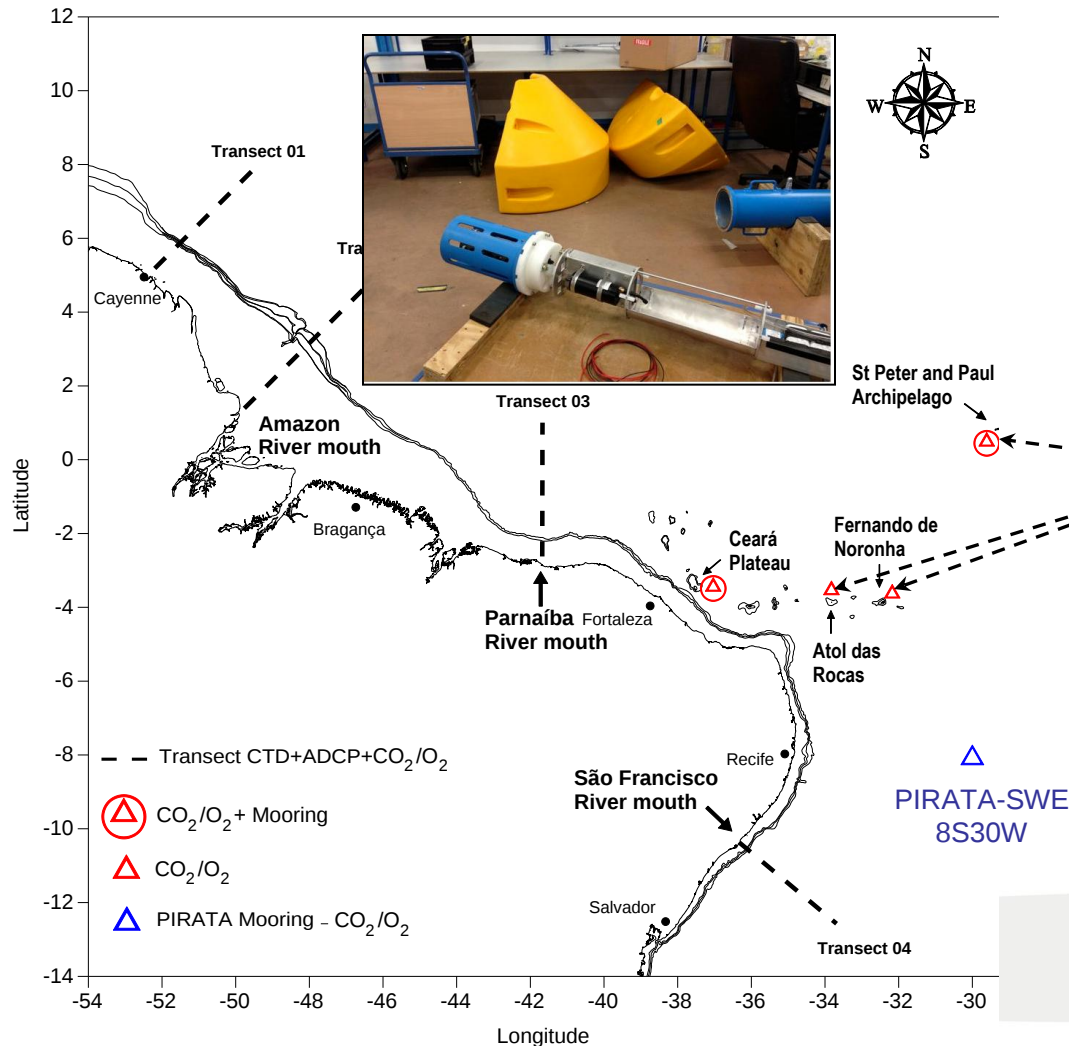
Bleaching events:

- 1998 - Strong
- 2003 - Strong
- 2007 - Strong
- 2009 - Observed

WP3.2 Observational network: CO₂ Ocean sites

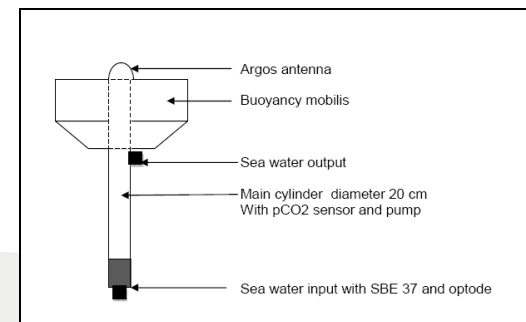
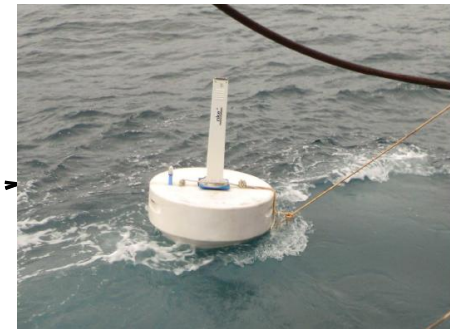
Long term *p*CO₂ measurements (Jan. 2014- ...)

Atoll Rocas, Noronha and ASPSP



CARIOCA-*p*CO₂

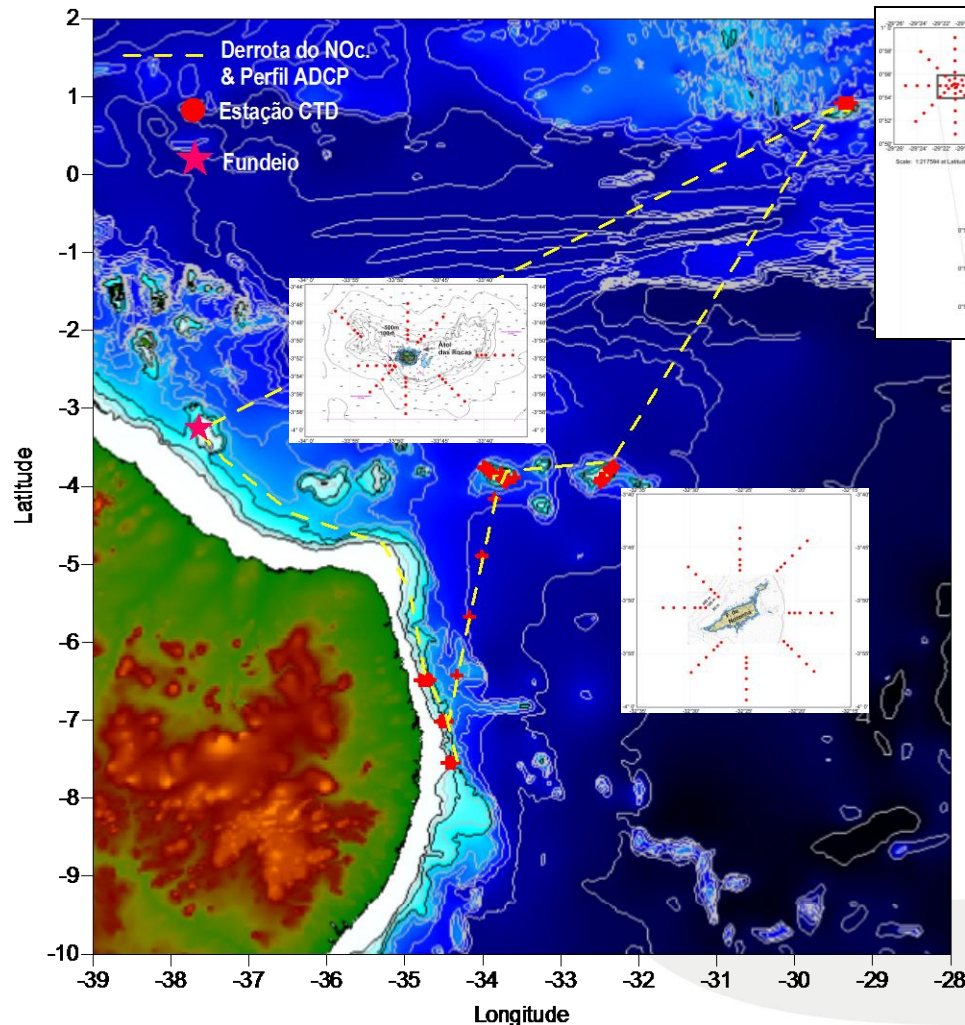
- *p*CO₂
- CTD
- OD



WP3.2 Observacional network: Oceanographic cruises

Camadas Finas II – Oceanic islands

Recife-Rocas-Noronha-ASPSP-Fortaleza: Sept. 16th – Oct. 5th 2012 ✓



NHO. Cruzeiro Sul

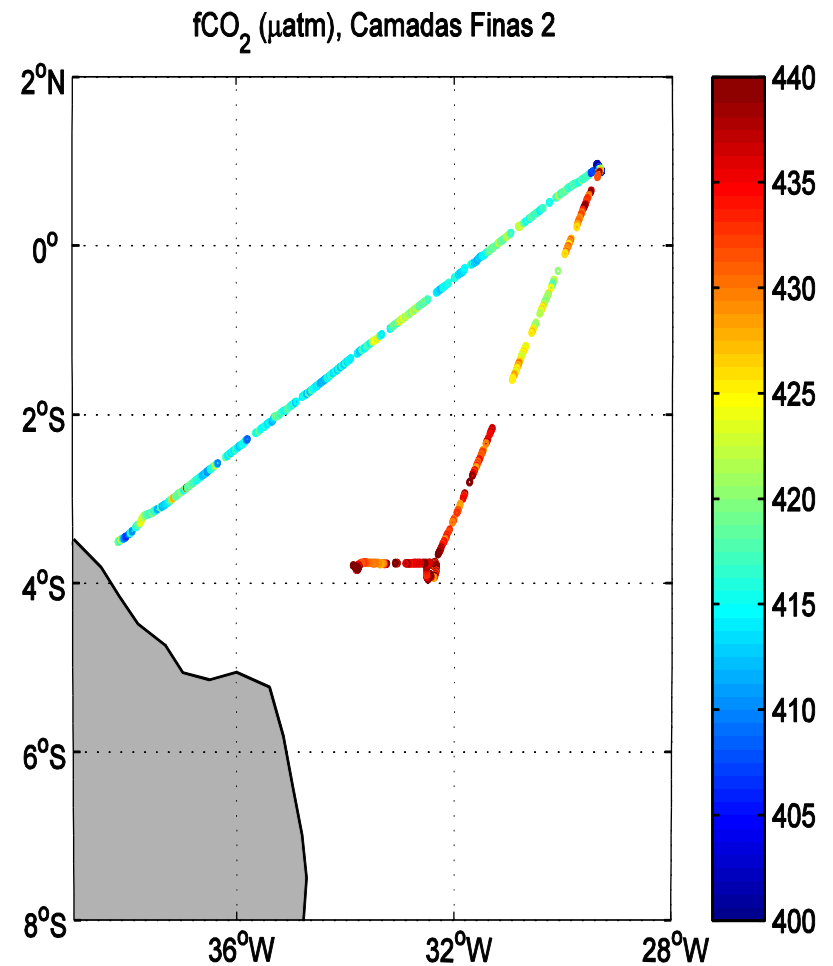
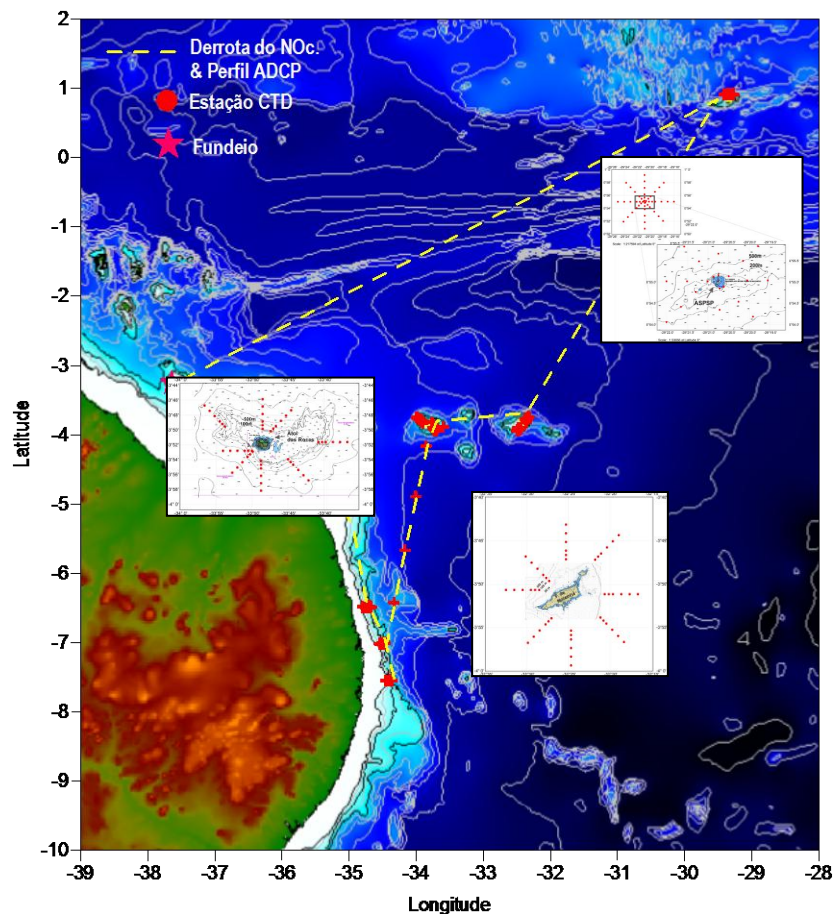


- uADCP, CTD
- N, P, Si ... series
- MES, Chla
- Phyto, Zoo
- Necton, , Neuston
- DIC, TALK, pH
- u-CO₂

WP3.2 Observacional network: Oceanographic cruises

Camadas Finas II – Oceanic islands

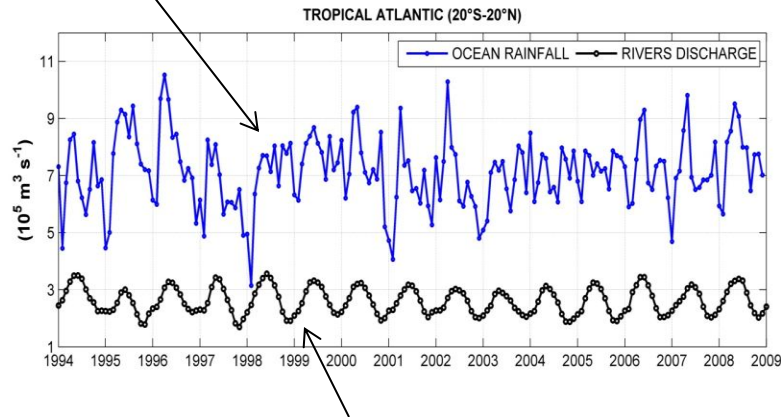
Recife-Rocas-Noronha-ASPSP-Fortaleza: Sept. 16th – Oct. 5th 2012 ✓



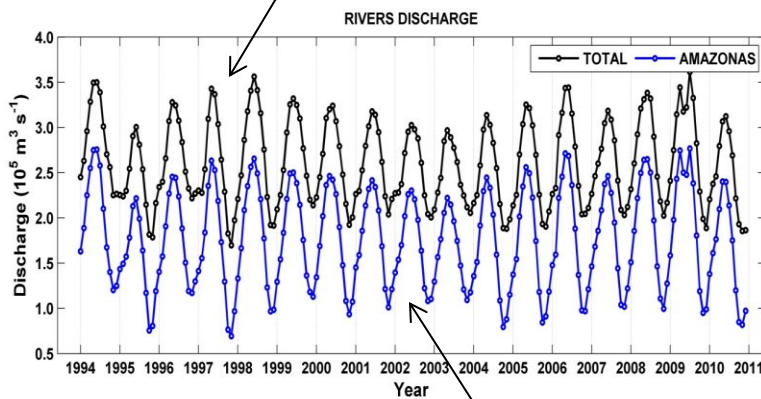
WG3.2: Biogeochemical Cycles, CO₂ Fluxes and Acidification of the TA

Large river plumes: Amazonas river

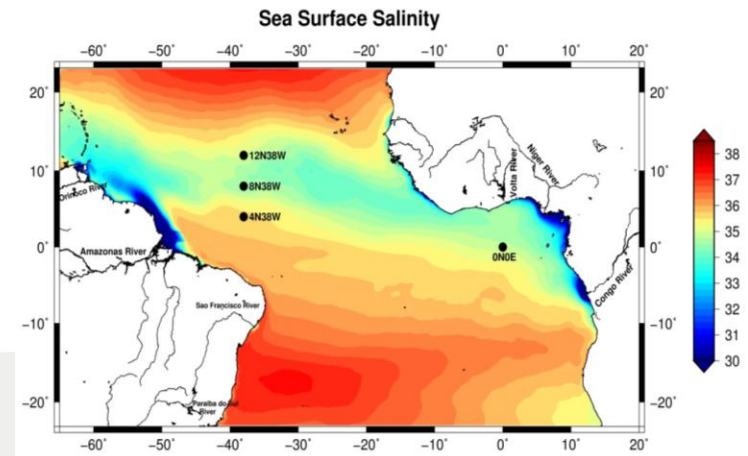
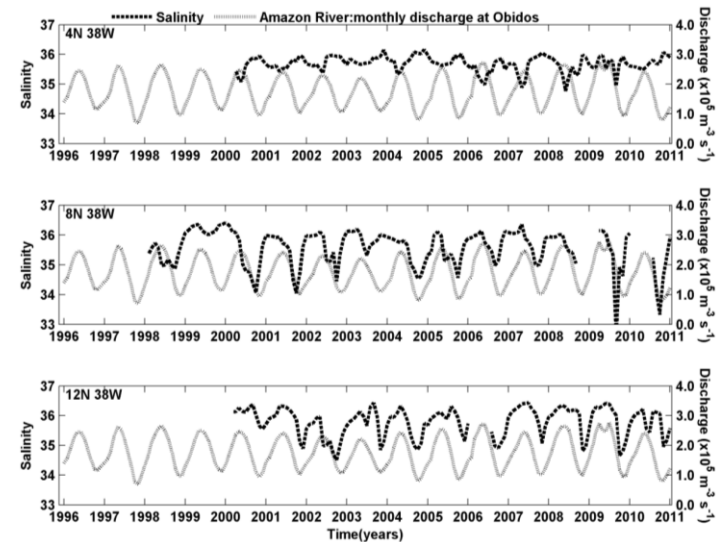
GPCP data



Amazon+S.Francisco+Orinoco+Congo+Volta+Niger



Amazon only



WG3.2: Biogeochemical Cycles, CO₂ Fluxes and Acidification of the TA

Large river plumes: Amazonas river

Amazon River enhances diazotrophy and carbon sequestration in the tropical North Atlantic Ocean

A. Subramaniam^{1*}, P. L. Yager², E. J. Carpenter³, C. Mahaffey⁴, K. Björkman⁵, S. Cooley⁶, A. B. Kustka^{7*}, J. P. Montoya^{1†}, S. A. Sanudo-Wilhelmy^{1‡}, R. Shipe^{8§}, and D. G. Capone^{1‡}

¹Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964; ²Department of Marine Sciences, University of Georgia, Athens, GA 30602; ³Romberg Tiburon Center, San Francisco State University, Tiburon, CA 94920; ⁴Department of Earth and Ocean Science, University of Liverpool, Liverpool L69 3GP, United Kingdom; ⁵Department of Oceanography, SOEST, University of Hawaii, Honolulu, HI 96822; ⁶Institute of Marine and Coastal Sciences, Rutgers, The State University of New Jersey, New Brunswick, NJ 08901; ⁷School of Biology, Georgia Institute of Technology, Atlanta, GA 30332; ⁸Wrigley Institute for Environmental Studies and Department of Biological Sciences, University of Southern California, Los Angeles, CA 90089; and [†]Department of Ecology and Evolutionary Biology and Institute of the Environment, University of California, Los Angeles, CA 90095

Edited by David M. Karl, University of Hawaii, Honolulu, HI, and approved April 24, 2008 (received for review October 29, 2007)

The fresh water discharged by large rivers such as the Amazon is transported hundreds to thousands of kilometers away from the coast by surface plumes. The nutrients delivered by these river plumes contribute to enhanced primary production in the ocean, and the sinking flux of this new production results in carbon sequestration. Here, we report that the Amazon River plume supports N₂ fixation far from the mouth and provides important pathways for sequestration of atmospheric CO₂ in the western tropical North Atlantic (WTNA). We calculate that the sinking of carbon fixed by diazotrophs in the plume sequesters 1.7 Tmol of C annually, in addition to the sequestration of 0.6 Tmol of C yr⁻¹ of the new production supported by NO₃ delivered by the river. These processes revise our current understanding that the tropical North Atlantic is a source of 2.5 Tmol of C to the atmosphere [Mikaloff-Fletcher SE, et al. (2007) Inverse estimates of the oceanic sources and sinks of natural CO₂ and the implied oceanic carbon transport. *Global Biogeochem Cycles* 21, doi:10.1029/2006GB002751]. The enhancement of N₂ fixation and consequent C sequestration by tropical rivers appears to be a global phenomenon that is likely to be influenced by anthropogenic activity and climate change.

diatom diazotroph associations | nitrogen fixation | new production | river plumes | *Richelia*

tions studied the plume in the open ocean beyond the shelf. We undertook three field campaigns to study the influence of the Amazon River on the carbon and nitrogen cycles beyond the shelf. Samples at a total of 82 stations in the WTNA in January to February 2001, July to August 2001, and April to May 2003 (Fig. 1 and Table S2) complement earlier studies by examining the region of the plume starting 300 km north of the mouth of the river. We classified the stations into three categories based on sea surface salinity (SSS).^{††} The “low salinity” group contained all of the stations with SSS <30. Stations that had SSS between 30 and 35 were classified as “mesohaline,” whereas those with SSS >35 were classified as “oceanic.”

Surface NO₃ concentrations were below detection at most stations, with the highest value of 0.50 μM recorded at the station with the lowest salinity of 24. DeMaster and Pope (7) found when plotting NO₃ vs. soluble reactive phosphorus (SRP) concentrations for samples taken from outside the river mouth and adjacent shelf, the SRP concentration was 0.14 μM at the zero NO₃ intercept, implying that the Amazon is an important source of “excess” SRP (N:P < 16) to the WTNA. Using SRP concentration in the river, Devol (8) calculated that the Amazon contributed ~30% of global riverine SRP flux to the ocean. This is very likely an underestimate because it does not include the

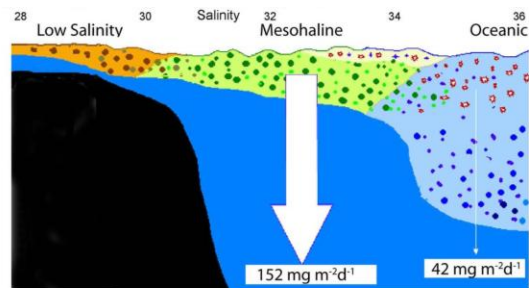
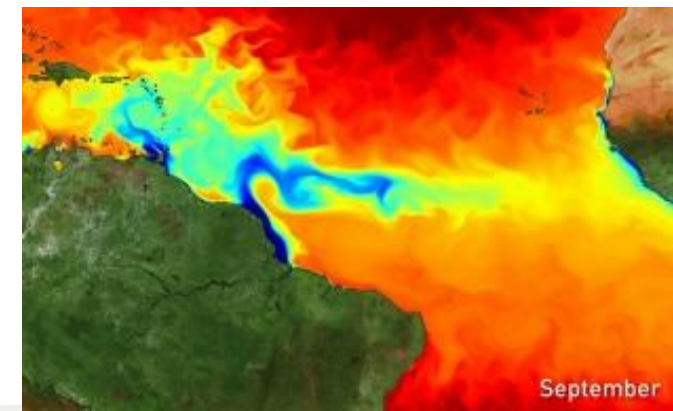
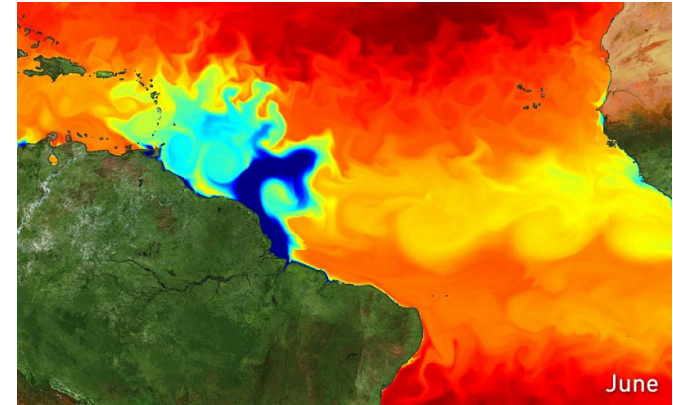


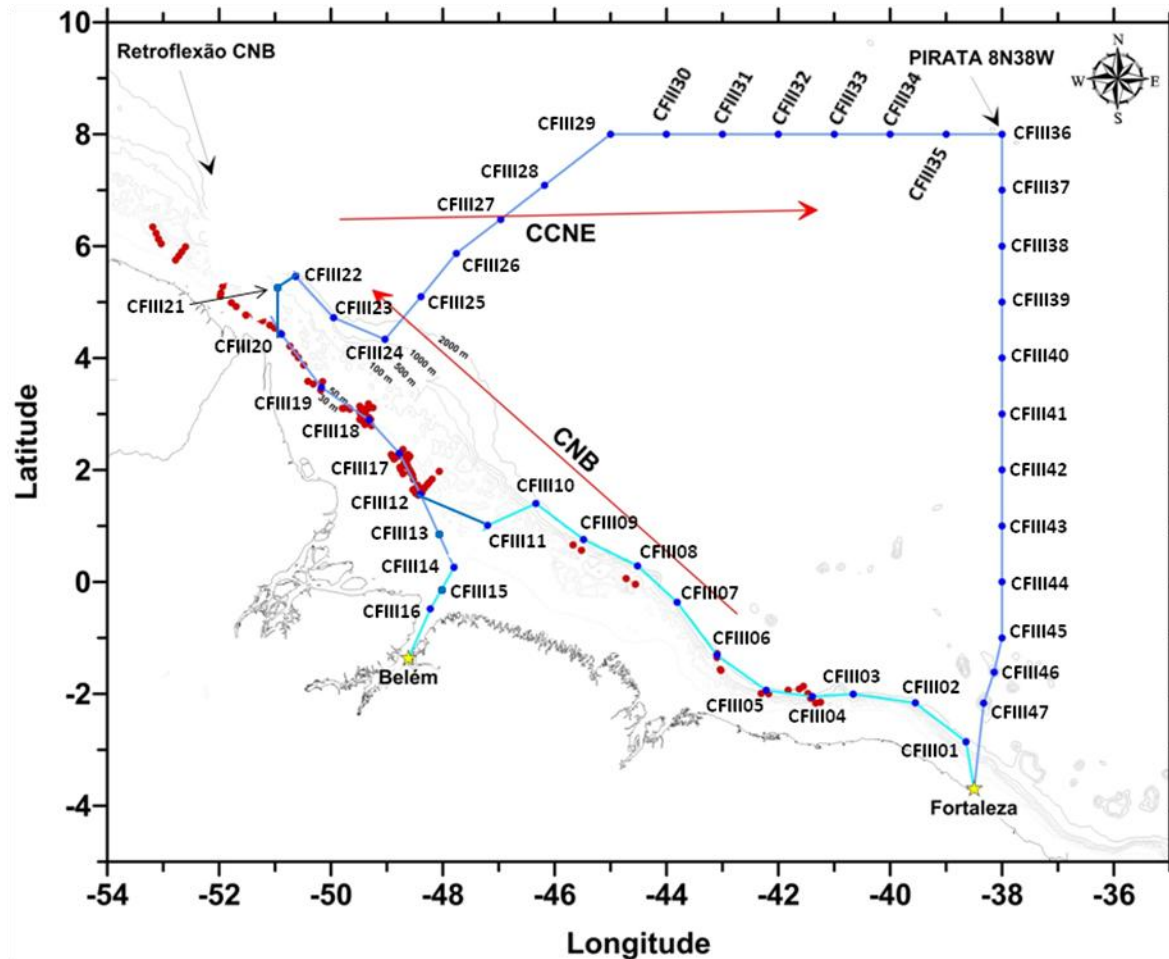
Fig. 3. Changes along the river plume as it moves offshore. (Top) Changes in surface nutrient concentrations as a function of salinity for each of the station types; the values and statistics are presented in Table 1. Error bars denote standard error; the thick horizontal line on the x axis indicates the mean salinity ± 1 S.E. for each group of stations. (Middle) Changes in biological response and mass flux from floating sediment traps at 200 m presented as in A. (Bottom) A schematic of changes along the plume; the arrows showing the mean mass flux for the mesohaline, and oceanic stations. The brown particles represent coastal phytoplankton species; the dark green represents DDA; the red represents *Trichodesmium*; and the blue represents particles typical of oligotrophic oceanic phytoplankton. Phytoplankton chlorophyll, *Trichodesmium*, and *Richelia* concentrations are given in Table 1. Water below the euphotic zone is depicted in solid dark blue, and the 1% light depths are given in Table 1.

MyOcean (2011)

WP3.2 Observacional network: Oceanographic cruises

Camadas Finas III - Amazon River plume

Fortaleza-Belém-Fortaleza: Oct. 9th – Nov. 1st 2012 ✓



NHO. Cruzeiro Sul

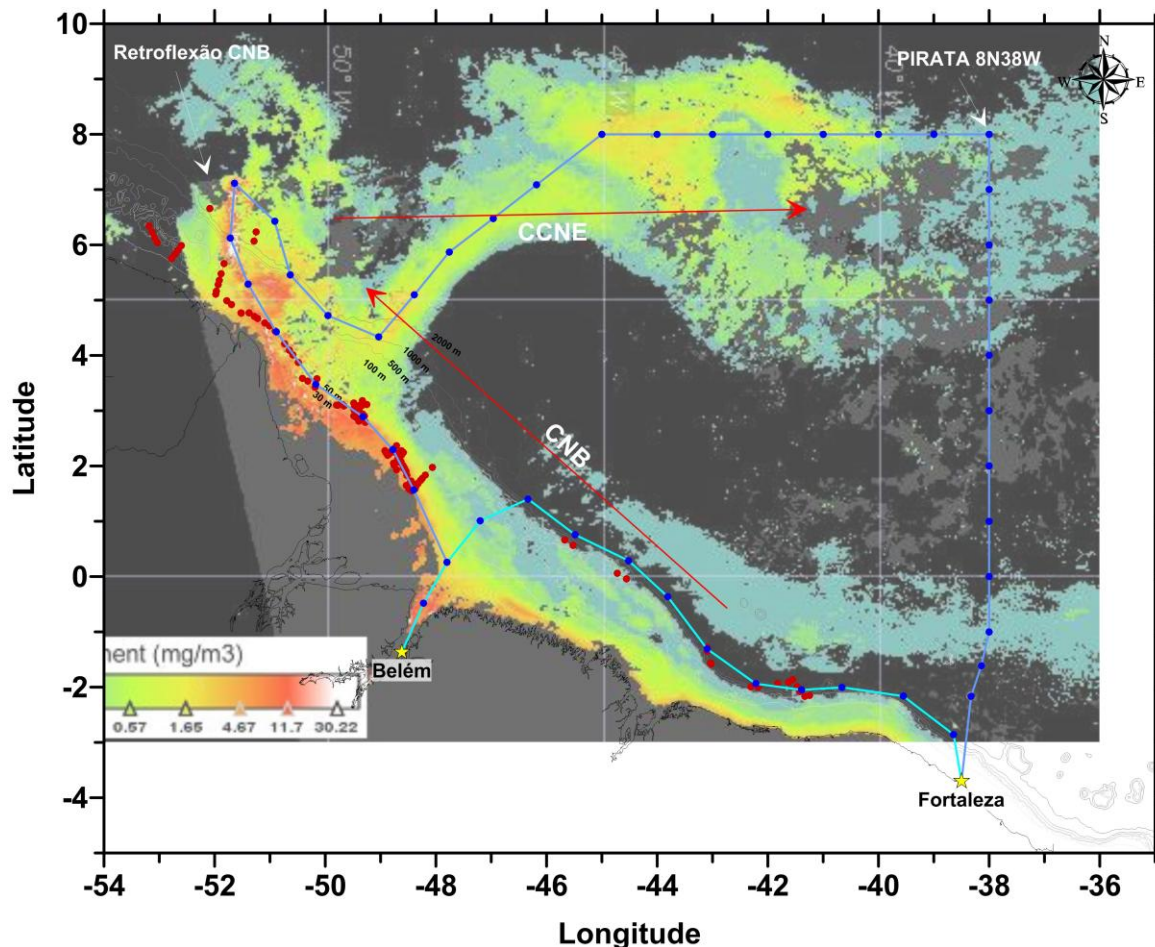


- uADCP, CTD
- N, P, Si ... series
- MES, Chla
- Phyto, Zoo
- Necton, , Neuston
- DIC, TALK, pH

WP3.2 Observacional network: Oceanographic cruises

Camadas Finas III - Amazon River plume

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NHO. Cruzeiro Sul

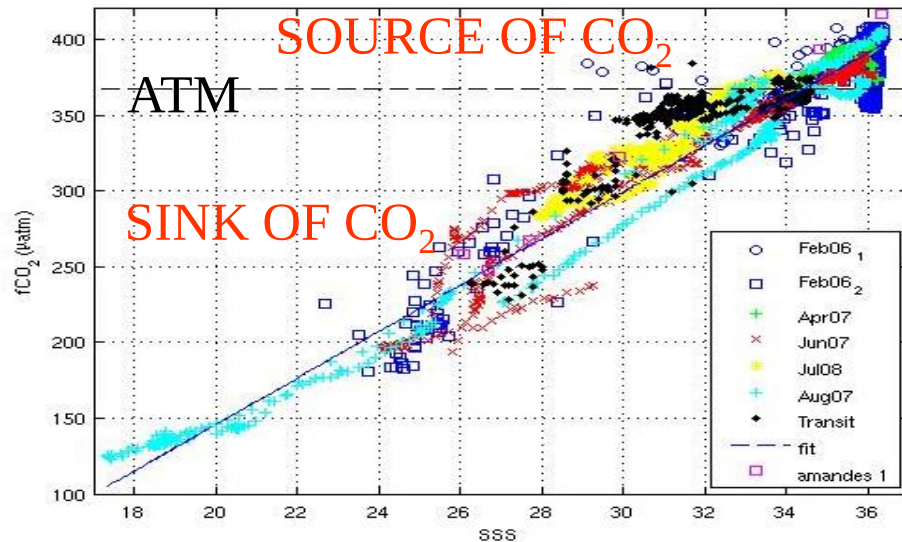
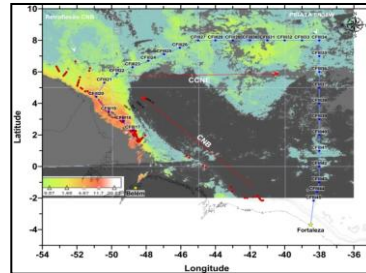
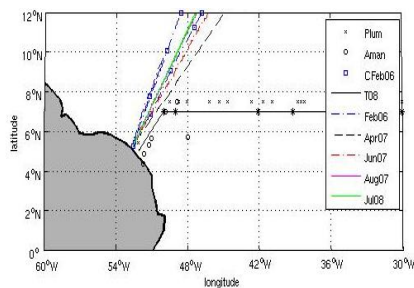


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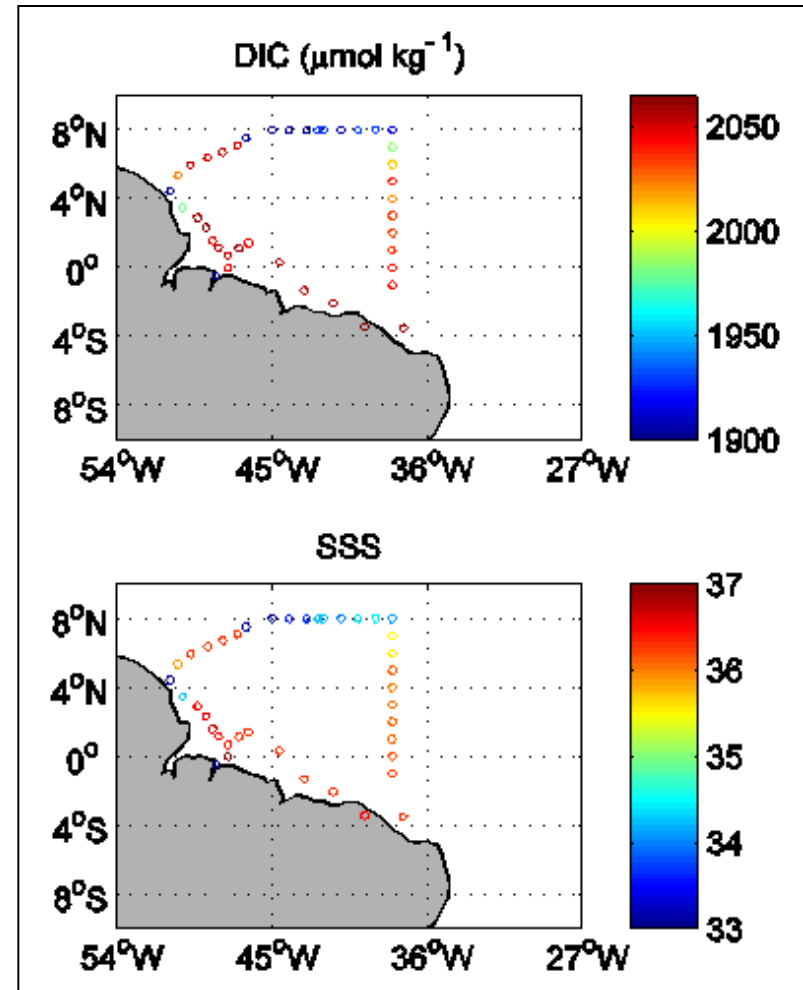
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Camadas Finas III - Amazon River plume

Fortaleza-Belém-Fortaleza: Oct. 9th – Nov. 1st 2012 ✓



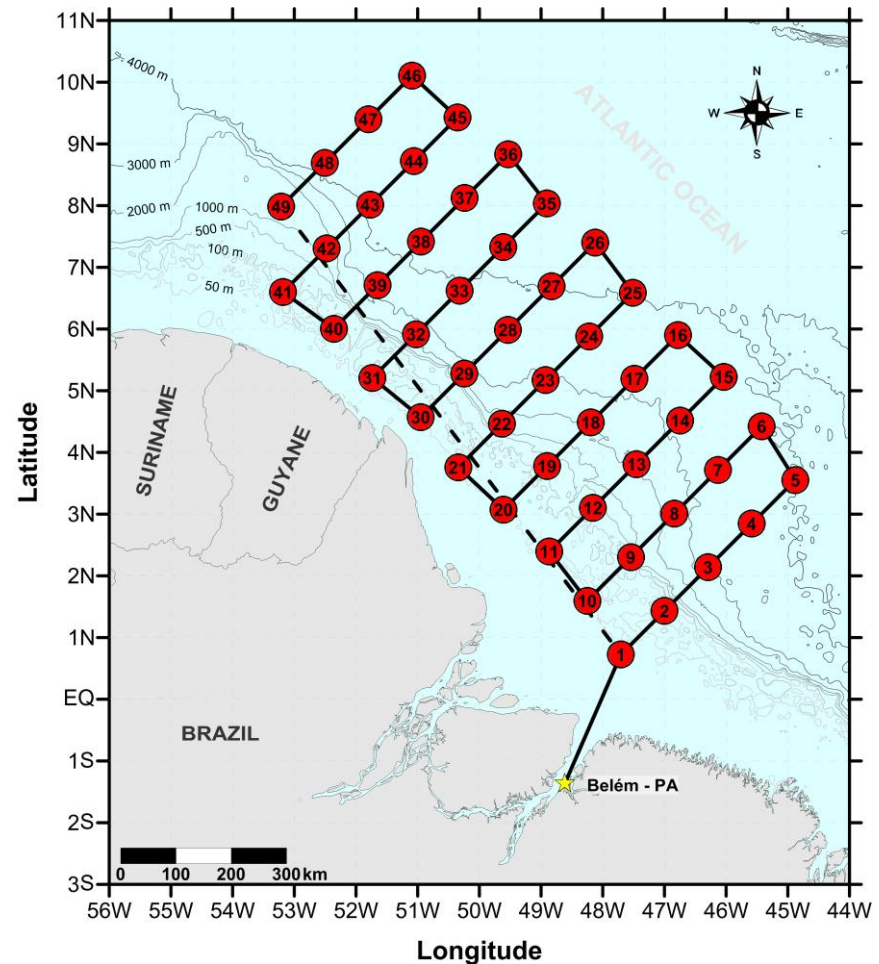
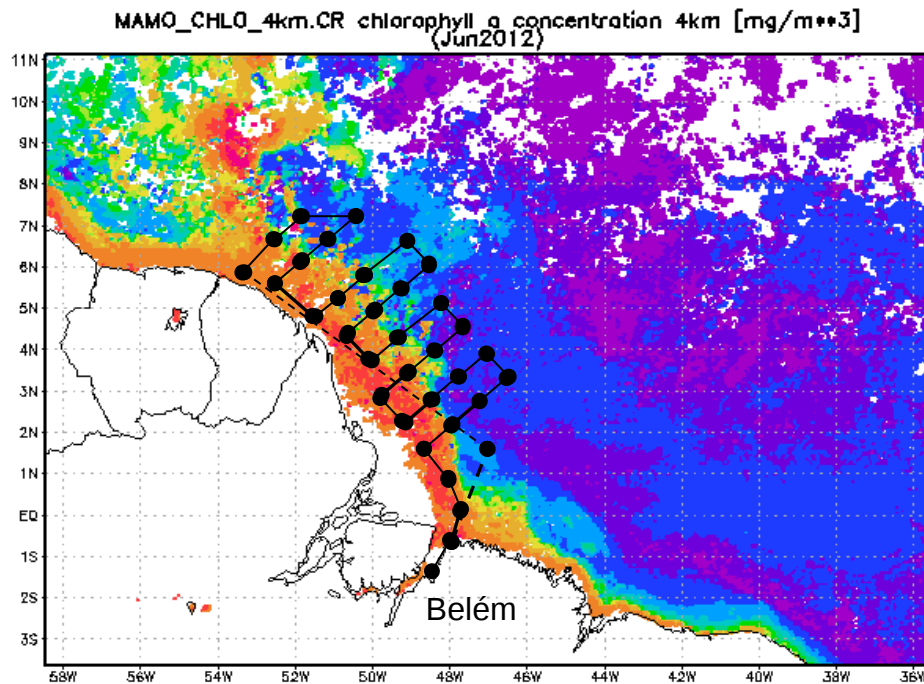
Sea surface salinity at 8°N, 38°W most affected by Amazon discharge (~1 month lag)



WP3.2 Observacional network: Oceanographic cruises

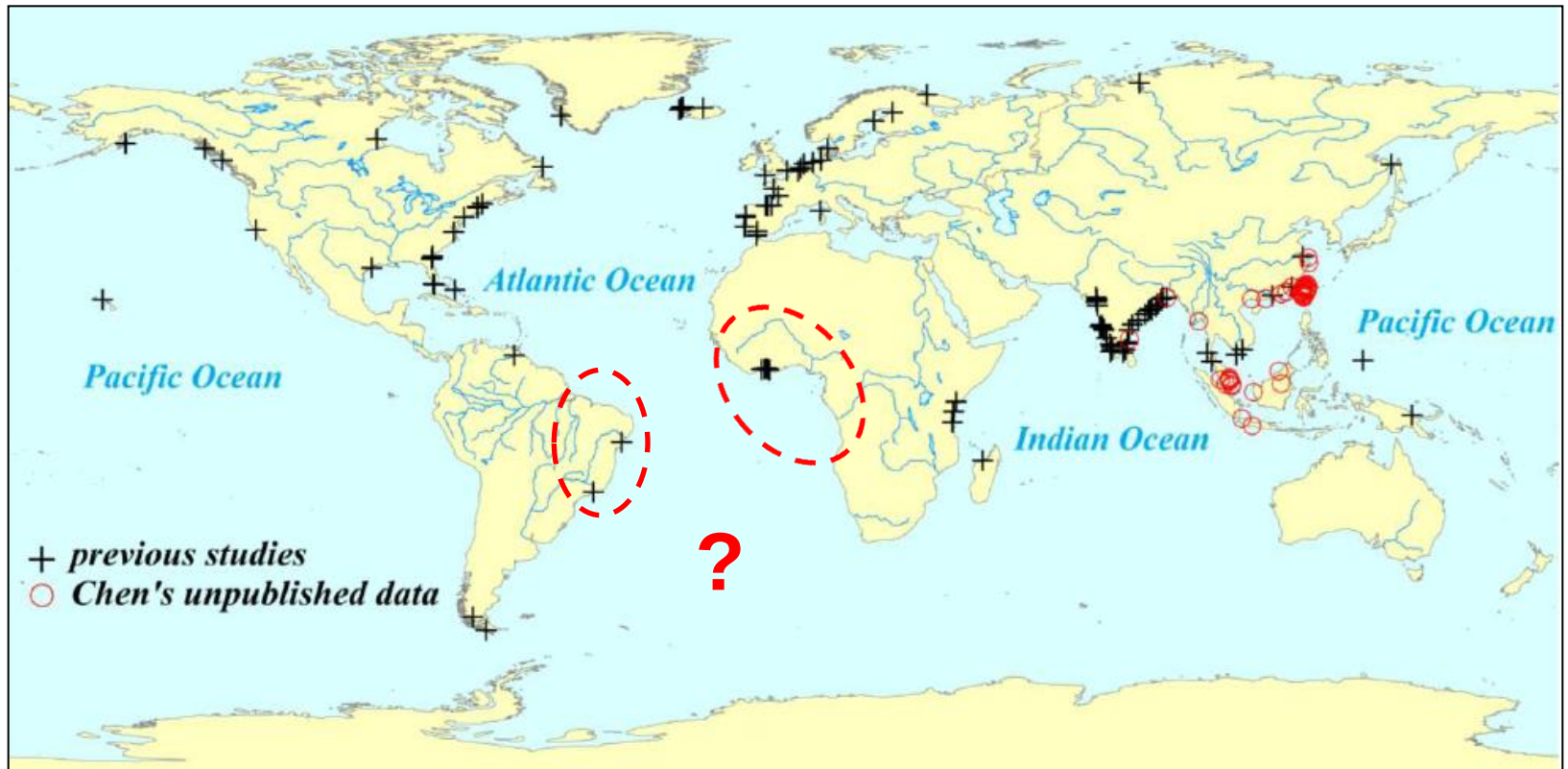
MCTI/SEPED 01/2013
Camadas Finas V
Low river discharge
(May-Jul 2014) ?

NHo. Cruzeiro Sul



WG3.2: Biogeochemical Cycles, CO₂ Fluxes and Acidification of the TA

Coastal seas and estuarine regions ...

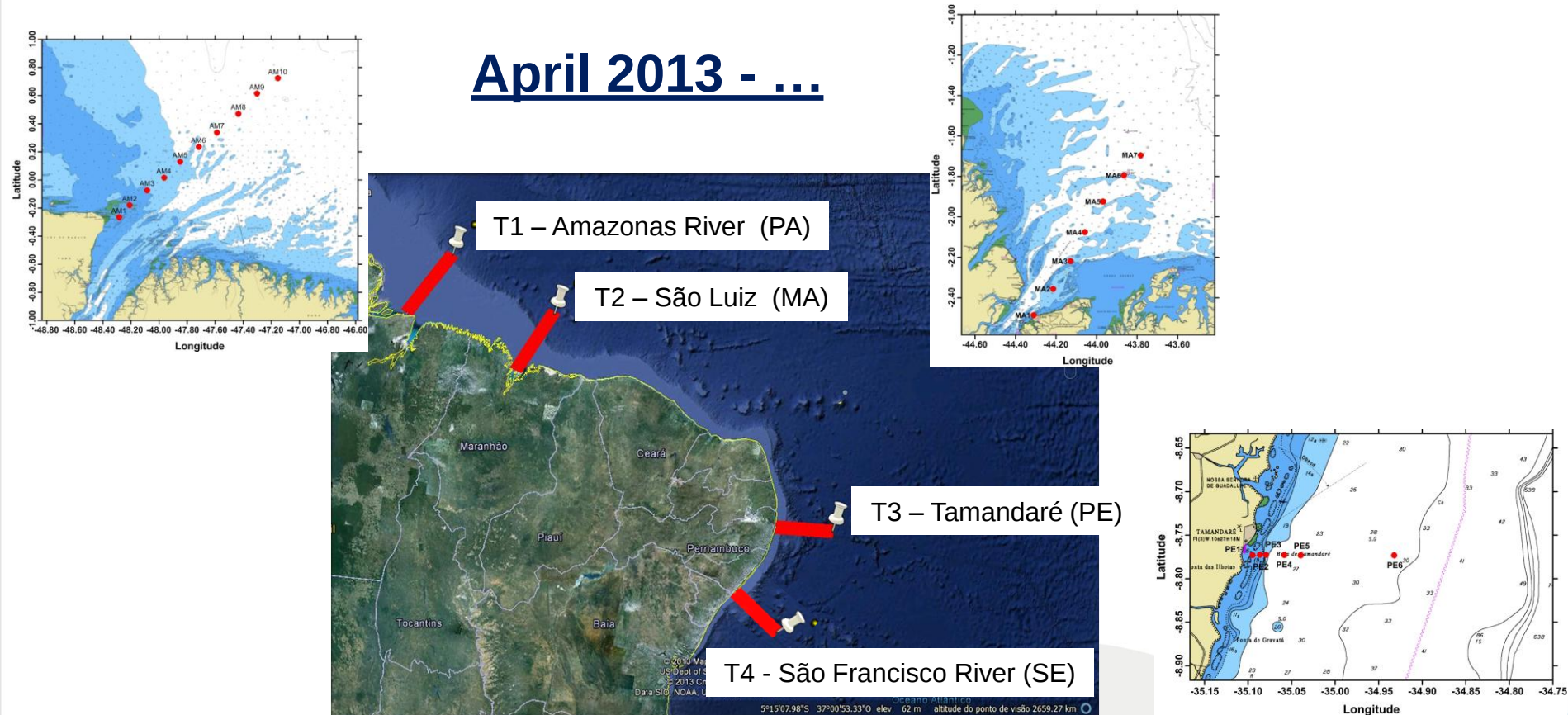


Air–sea exchanges of CO₂ in the world's coastal seas
Chen et al. (2013)

WG3.2: Biogeochemical Cycles, CO₂ Fluxes and Acidification of the Tropical Atlantic

Bimonthly water sampling (pH/DIC/TA) in different cross-shelf transects along the North-Northeastern Brazilian coast, from the Amazon River (equator) to the São Francisco River (10°S).

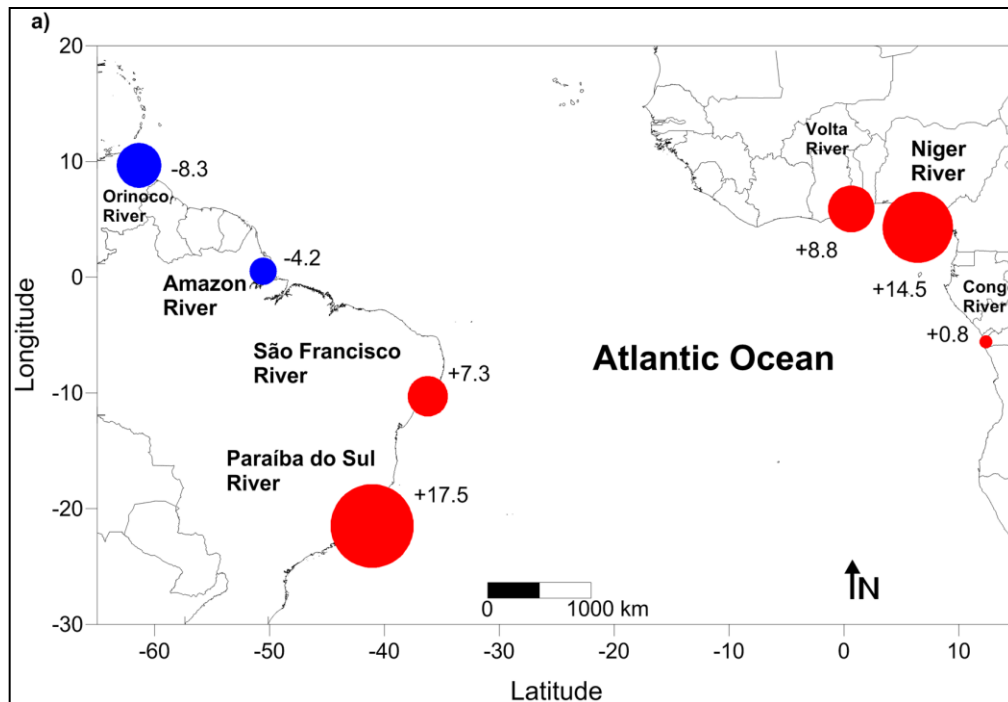
April 2013 - ...



WG3.2: Biogeochemical Cycles, CO₂ Fluxes and Acidification of the TA

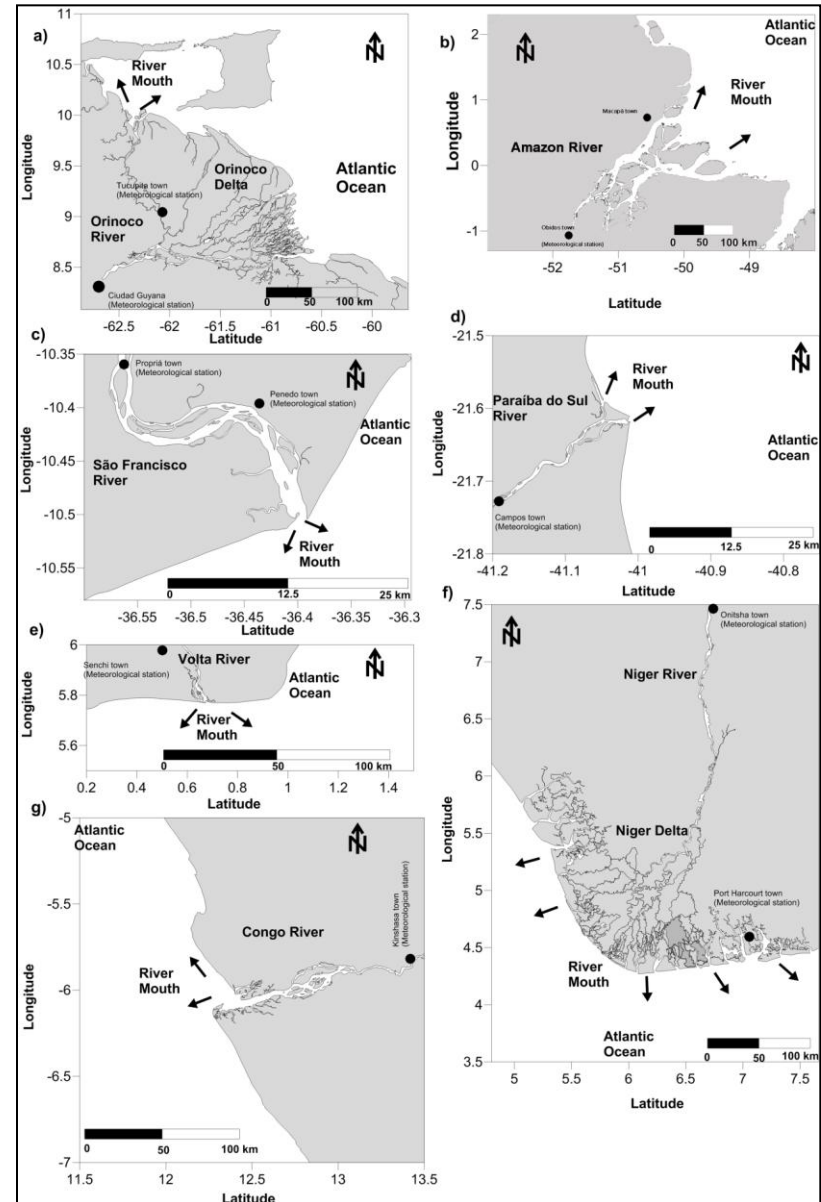
Coastal seas and estuarine regions ...

CO₂ flux (mmol C m⁻² day⁻¹)



Red circles (+) source of CO₂ for the atmosphere.
Blue circles (-) atmospheric CO₂ sinks.

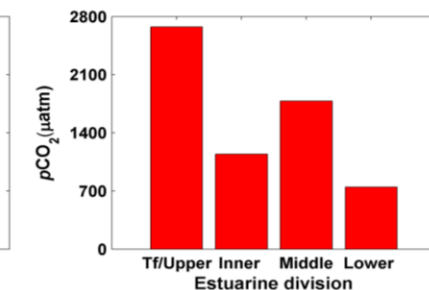
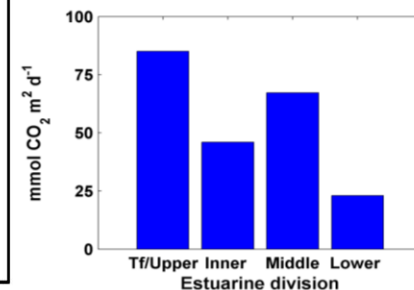
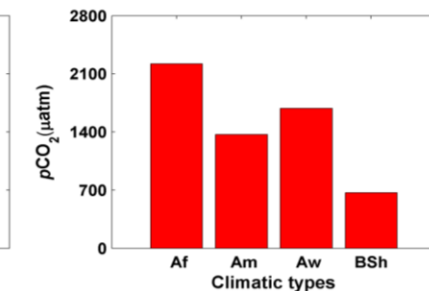
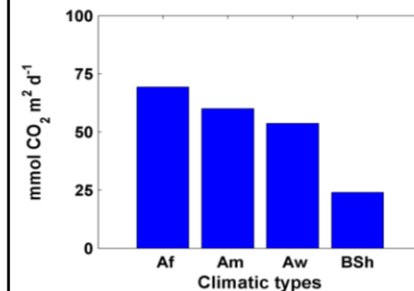
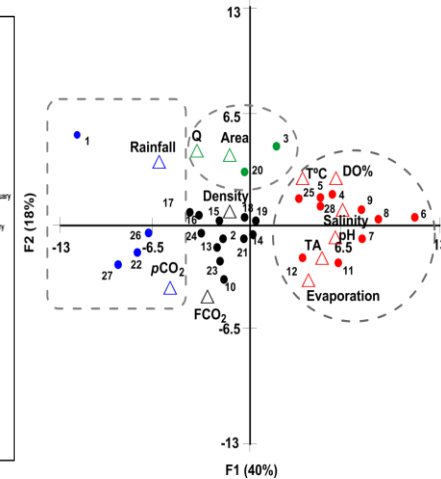
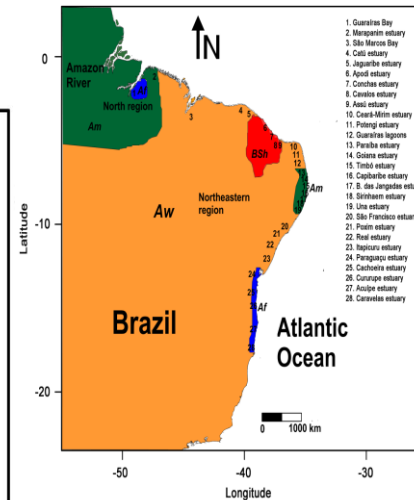
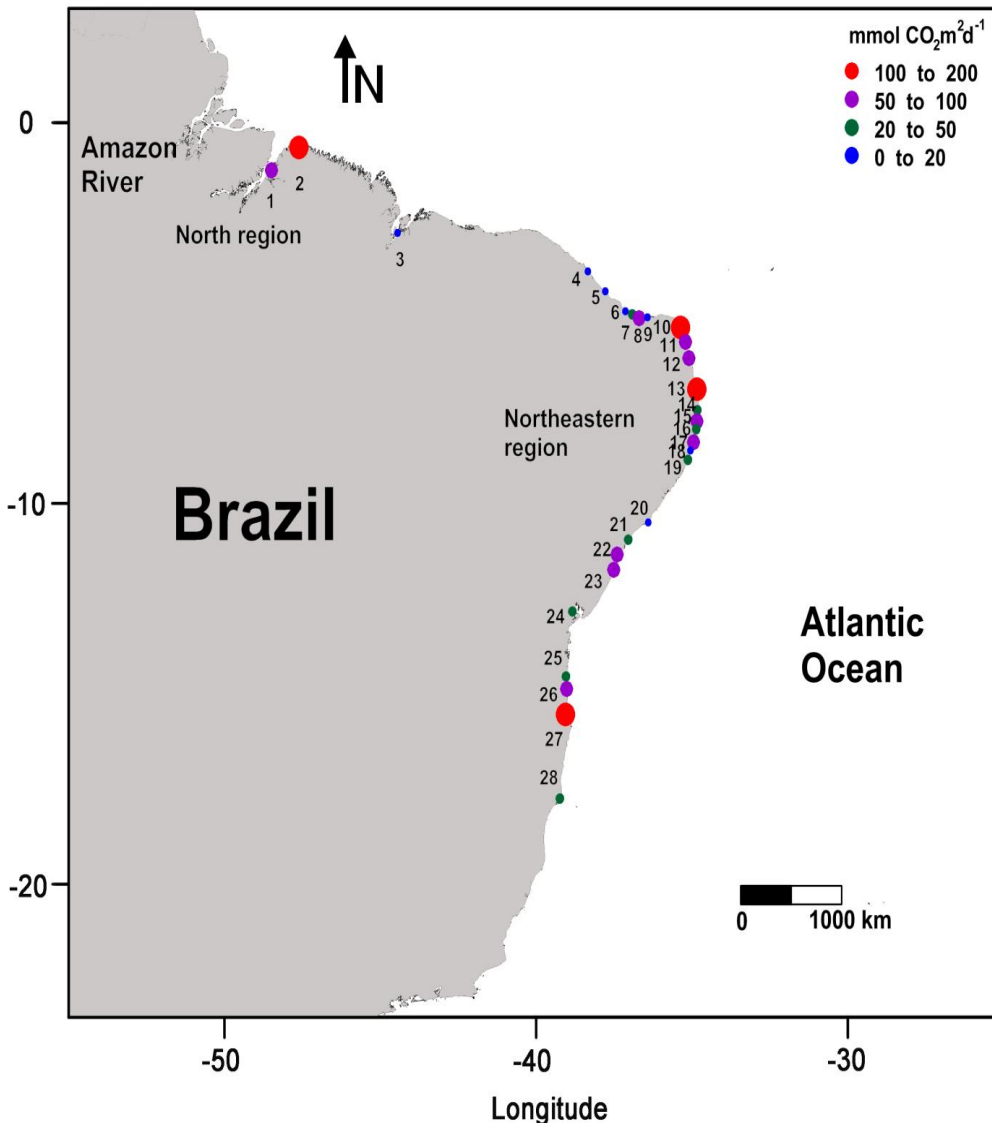
Araujo et al. (2013), *subm.*



WG3.2: Biogeochemical Cycles, CO₂ Fluxes and Acidification of the TA

Coastal seas and estuarine regions ...

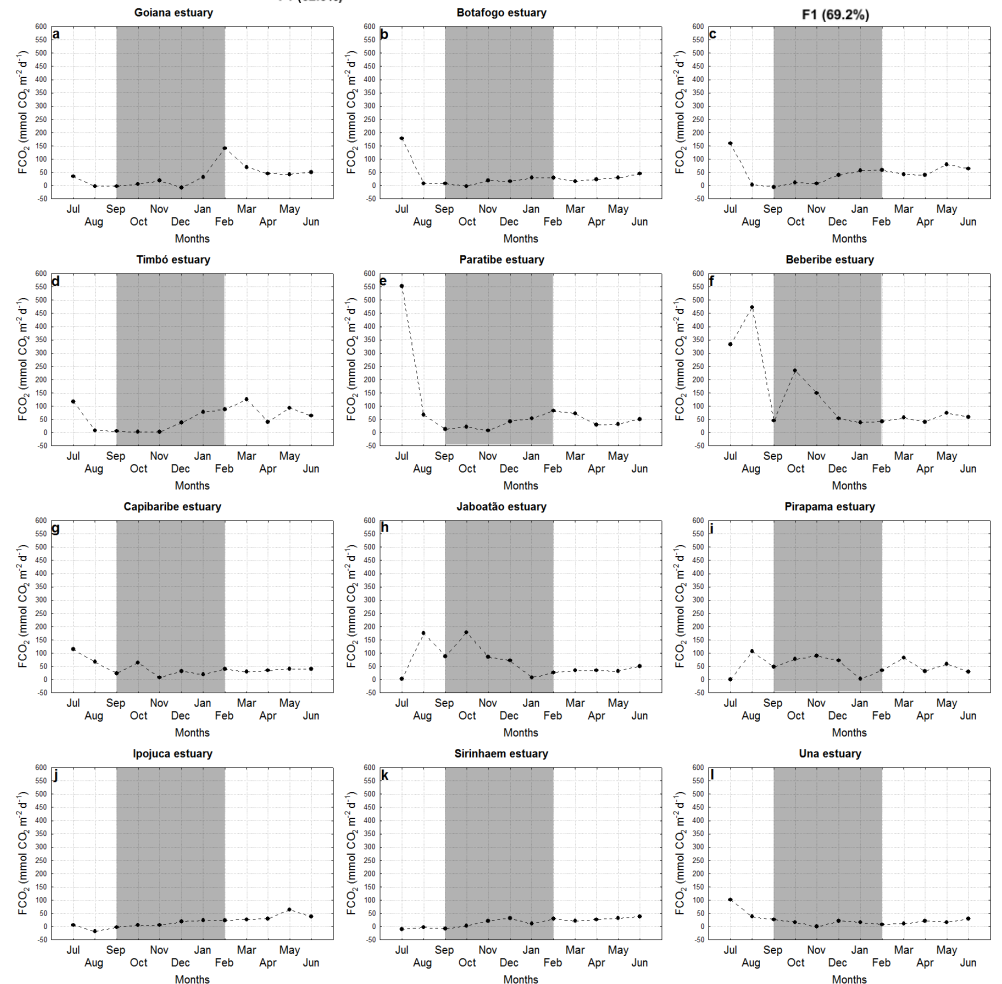
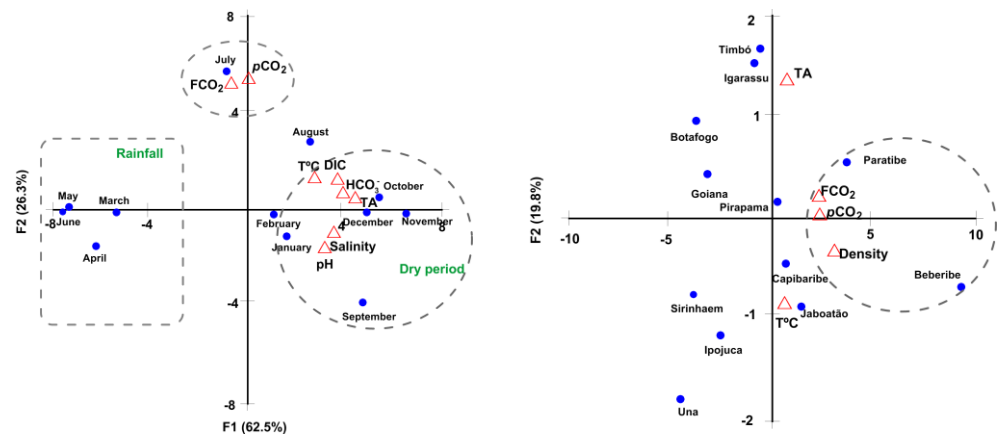
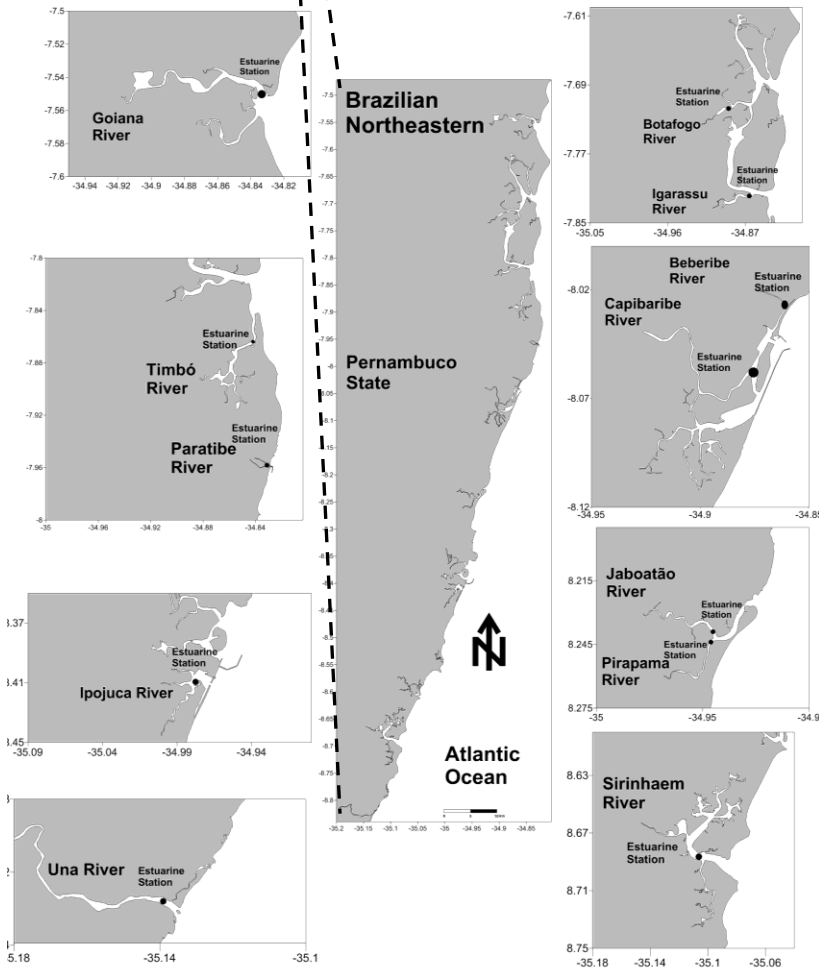
McLusky (1993)



Noriega & Araujo (2013), *subm.*

Coastal seas and estuarine regions ...

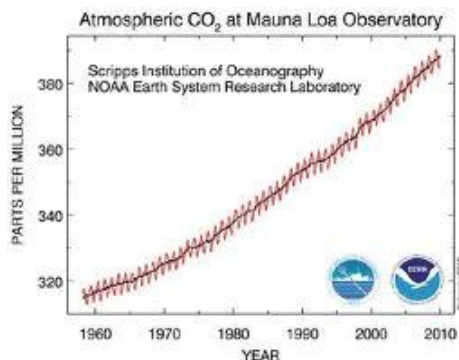
$$FCO_2 = 51 \pm 32 \text{ mmol m}^{-2} \text{ d}^{-1}$$



Outline

- **Prediction and Research Moored Array in the Tropical Atlantic - PIRATA (1998-...)**
- **National Institute on Science & Technology in Tropical Marine Environments - INCT-AmbTropic (2012-2017)**
WP3.2: Biogeochemical Cycles, CO₂ Fluxes and Acidification of the Tropical Atlantic
- **Associated Projects:**
 - CO2-Brazil (CNPq 403241/2012-0)
 - ARQ_MODEL II (CNPq 405350/2012-0)
 - MoU DOCEAN/UFPE - GEOMAR (Meteor M98/M106)
 - MoU DOCEAN/UFPE - IIM-CSIC (FICARAM 15)

CO₂-Brazil (CNPq 403241/2012-0) (PI: Humberto Rocha, IAG-USP)



Racional: obtenção de séries de longa duração de **GEE** em ambiente isolado e pouco antropizado.

Transporte ventos alísios.

Amostragem: medições simultâneas de frações molares (concentração) de **Metano**, **Dióxido de Carbono** e Vapor d'água.

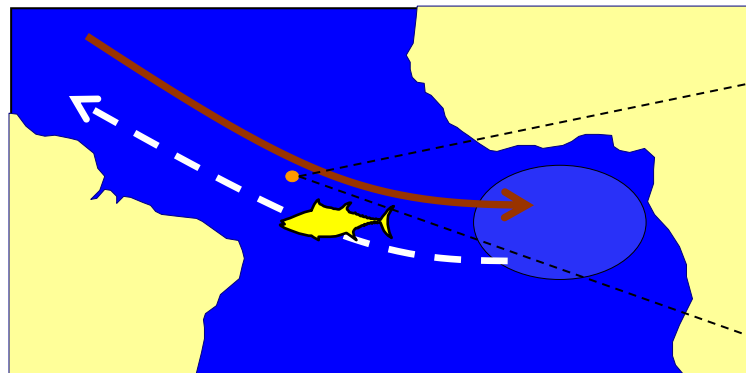
Previsão: 1o. Sem. 2014



**Morro do Pico
320 m (MSL)**

F. Noronha

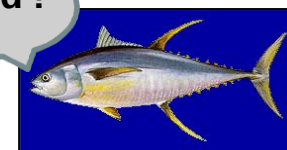
ARQ_MODEL II (CNPq 405350/2012-0) (PI: Moacyr Araujo, DOCEAN-UFPE)



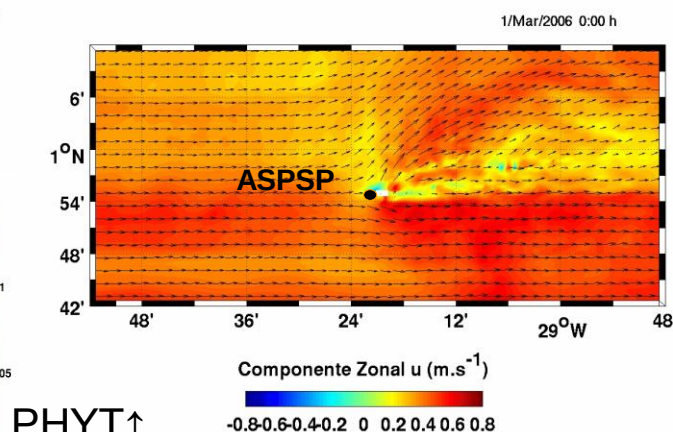
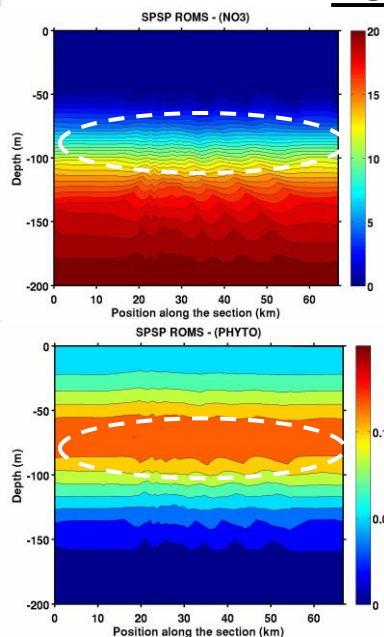
St. Peter and St. Paul Archipelago - ASPSP



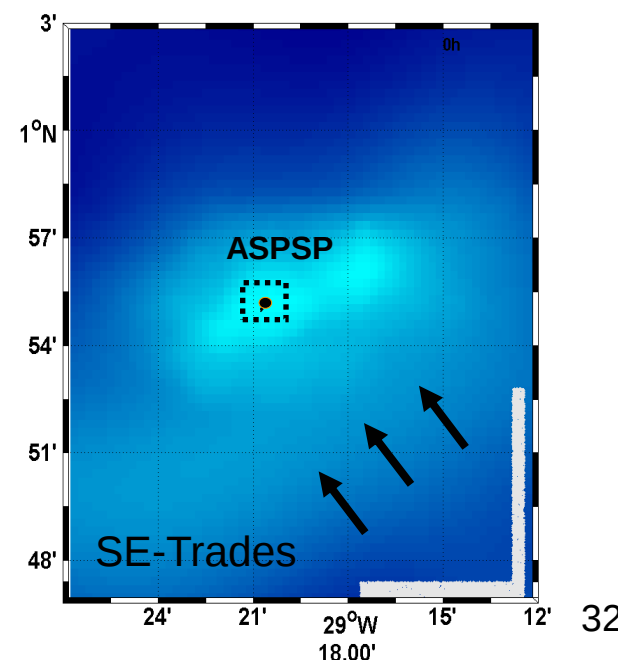
Good !



EUC eddies (Z = -100 m)



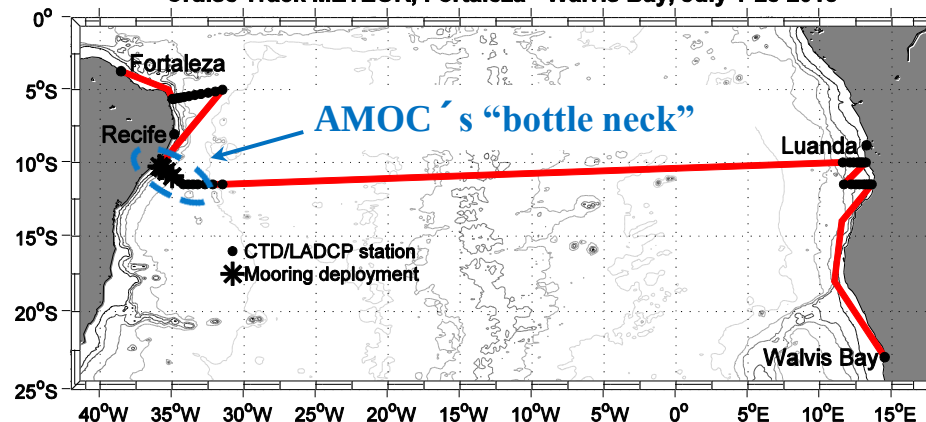
Larvae recruitment (Z = 0 m)



MoU DOCEAN/UFPE - GEOMAR (Meteor M98/M106)

- ...+ N₂O, CO₂, DMS, O₂, u-CO₂

Cruise Track METEOR, Fortaleza - Walvis Bay, July 1-28 2013



Laboratório de Oceanografia Física Estuarina e Costeira,
Departamento de Oceanografia da
Universidade Federal de Pernambuco,
Av. Arquitetura, s/n
50740-550 - Cidade Universitária
Recife, Brasil

and

Forschungsbereich Ozeanzirkulation und Klimadynamik,
Physikalische Ozeanographie,
GEOMAR | Helmholtz-Zentrum für Ozeanforschung Kiel,
Düsternbrooker Weg 20
24105 Kiel, Germany

In recognition of the common interest shared by the Laboratório de Oceanografia Física Estuarina e Costeira, Departamento de Oceanografia da Universidade Federal de Pernambuco, Recife, Brazil, and the Forschungsbereich Ozeanzirkulation und Klimadynamik, Physikalische Ozeanographie, GEOMAR | Helmholtz-Zentrum für Ozeanforschung Kiel, Germany, the objective of this Memorandum of Understanding is to describe the principles of the joint planned research program in the tropical Southwest Atlantic. This program includes several German research cruises to observe the western boundary current regime off Brazil North of 12°S. These cruises will enhance interaction between both groups, including joint data collection, professional staff and student exchange-training, joint research and joint publications. This work intends strong cooperation with the international PIRATA tropical Atlantic program including PIRATA-Brazil with its Southwest extension (PIRATA-SWE) that was established in September, 2005 as well as cooperation with the Brazilian National Institute on Science & Technology in Tropical Marine Environments (INCT-AmbTropic) program.

Prof. Dr. Moseyr Cunha de Araujo Filho
Laboratório de Oceanografia Física Estuarina e Costeira,
Departamento de Oceanografia da Universidade Federal de Pernambuco,
Recife, Brazil.

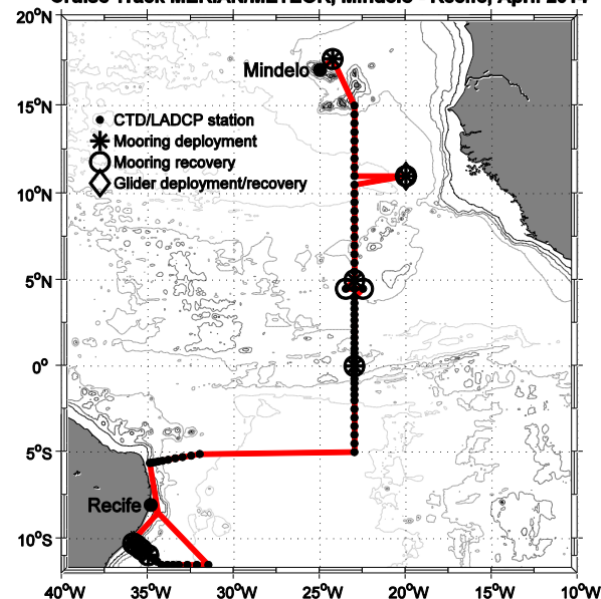
Date: 25.05.2012

Prof. Dr. Peter Brandt
Forschungsbereich Ozeanzirkulation und Klimadynamik,
Physikalische Ozeanographie,
GEOMAR | Helmholtz-Zentrum für Ozeanforschung Kiel,
Kiel, Germany

Date: 25.05.2012

Prof. Dr. Peter Brandt
GEOMAR
Helmholtz-Zentrum
für Ozeanforschung Kiel
FRI - Ozeanforschung und Klimadynamik
Düsternbrooker Weg 20
24105 Kiel

Cruise Track MERIAN/METEOR, Mindelo - Recife, April 2014



MoU DOCEAN/UFPE – IIM/CSIC (FICARAM 15)

Laboratório de Oceanografia Física Estuarina e Costeira,
Departamento de Oceanografia da
Universidade Federal de Pernambuco,
Av. Arquitetura, s/n
50740-550 - Cidade Universitária
Recife, Brasil

and

Instituto de Investigaciones Marinas from Consejo Superior de
Investigaciones Científicas,
IIM-CSIC
Eduardo Cabello, 6
36208 Vigo, Spain

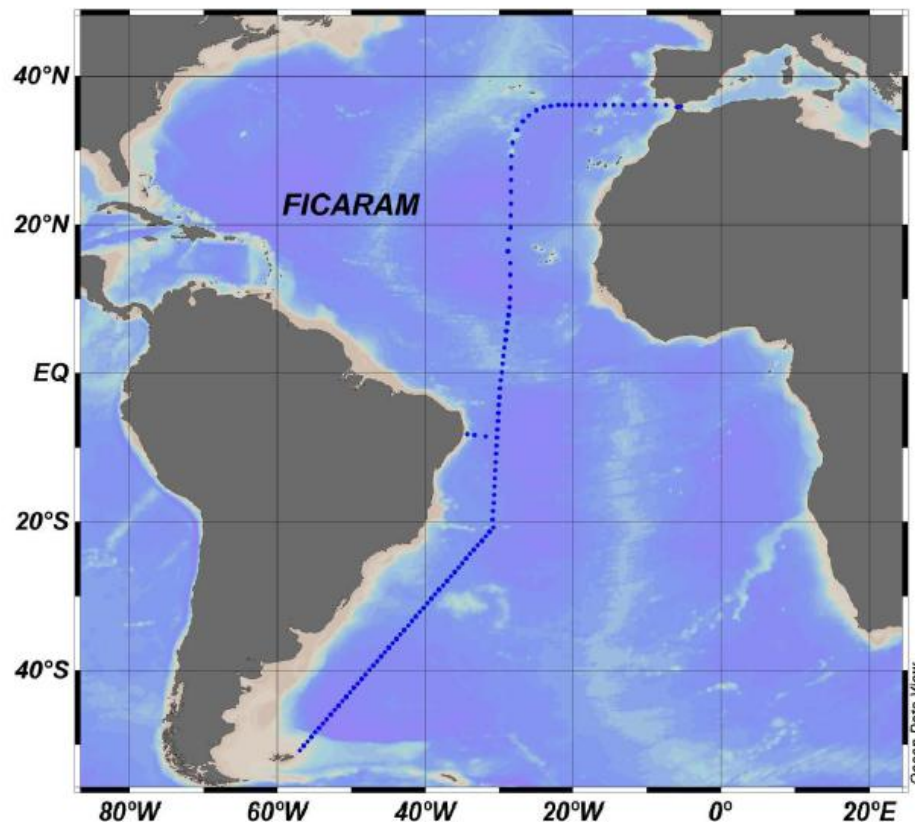
In recognition of the common interest shared by the Laboratório de Oceanografia Física Estuarina e Costeira, Departamento de Oceanografia da Universidade Federal de Pernambuco, Recife, Brazil, and the Instituto de Investigaciones Marinas from Consejo Superior de Investigaciones Científicas (IIM-CSIC) in Vigo, Spain, the objective of this Memorandum of Understanding is to describe the principles of the joint planned research program in the Atlantic Ocean. This program includes the Spanish research cruise FICARAM to observe the western boundary current regime off Brazil and the influence of the Mediterranean Water. These cruises will enhance interaction between both groups, including joint data collection, professional staff and student exchange/training, joint research and joint publications. This work intends strong cooperation with the international PIRATA tropical Atlantic program including PIRATA-Brazil with its Southwest extension (PIRATA SWEX) that was established in September, 2005 as well as cooperation with the Brazilian National Institute on Science & Technology in Tropical Marine Environments (INCT-AmbTropic) program, and with the International Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP) that was established in 2007.

Prof. Dr. Moacyr Cunha de Araujo Filho
Laboratório de Oceanografia Física Estuarina e Costeira,
Departamento de Oceanografia da Universidade Federal de Pernambuco,
Recife, Brazil.

Date: 29 January 2013.

Prof. Dr. Aida Fernández Ríos
Instituto de Investigaciones Marinas of Consejo Superior de Investigaciones Científicas,
IIM-CSIC
Vigo, Spain

Date: 29 January 2013



Punta Arenas-REC- Cartagena
- ...+ DIC/Talk, u-CO₂, etc..



Capacity building at UFPE (Staff)



Com vínculo

1. Dr. Moacyr Cunha de Araujo Filho
Prof. Associado DOCEAN-CEERMA/UFPE

2. Dr. Marcus André Silva
Prof. Adjunto DOCEAN-CEERMA/UFPE

3. Dra. Doris Regina Aires Veleza
Prof. Adjunto DOCEAN-CEERMA/UFPE

4. Dr. Manuel Flores Montes
Prof. Adjunto DOCEAN-DQUIM/UFPE

5. Dr. Marcio Moura Chagas
Prof. Adjunto DEP-CEERMA/UFPE

6. Dr. Enrique Andrès Lopez Droguett
Prof. Adjunto DEP-CEERMA/UFPE

7. Dr. Héctor Raul Montagne Dugrós
Prof. Adjunto DFIS/UFRPE-CEERMA/UFPE

8. MSc. Leonardo Vieira Bruto da Costa
Técnico Nível Superior DOCEAN-CEERMA/UFPE

9. Dra. Fabiana Soares Leite
Técnico Nível Superior DOCEAN-CEERMA/UFPE

Sem vínculo

10. Dr. Carlos Esteban Delgado Noriega
Bolsista DTI INCT-AmbTropic

11. Dra. Isis Didier Lins
Bolsista DTI INCT-AmbTropic



Capacity building at UFPE (PhD thesis)



1. Felipe Lima Gaspar. Fluxos de CO₂ e dinâmica do carbono inorgânico no bioma costeiro-marinho de Pernambuco. (2011-2015). CNPq/CAPES.

Dir.: Manuel Flores-Montes (UFPE, Brazil)

Co-Dir.: Nathalie Lefèvre (LOCEAN/IRD, France)

2. Frédéric Kpèdonou Bonou. Variability of parameters controlling the CO₂ flux on the western boundary of the tropical Atlantic. (2012-2016). FACEPE.

Dir.: Moacyr Araujo (UFPE, Brazil)

Co-Dir.: Nathalie Lefèvre (LOCEAN/IRD, France)

3. Leonardo Vieira Bruto da Costa. CO₂ flux through ocean-atmosphere interface at ocean reef systems. (2012-2016). CNPq/CAPES.

Dir.: Moacyr Araujo (UFPE, Brazil)

Co-Dir.: Nathalie Lefèvre (LOCEAN/IRD, France)

Capacity building at UFPE (PhD thesis) (cont.)

4. Christine Carine Tchamabi. Modelagem matemática da circulação, da dispersão de nutrientes e plâncton, e da troca oceano-atmosfera de CO₂ no Atlântico tropical. **(2013-2017). FACEPE.**

Dir.: Moacyr Araujo (UFPE, Brazil)

Co-Dir.: Guy Caniaux (CNRM, France)

5. Pedro Tyaquiçã. Modeling the light field in the waters of Equatorial Atlantic under the effects of the Amazon River discharge: implication to biogeochemical processes and primary production. **(2013-2017). CNPq.**

Dir.: Moacyr Araujo (UFPE, Brazil)

Co-Dir.: Maycira Costa (UVic, Canadá)

6. Bárbara Ramos Pinheiro. Perspectiva dos efeitos do aumento do CO₂ atmosférico sobre os organismos construtores de coral do Atol das Rocas-RN, Brasil. PPGO/DOCEAN **(2013-2017). Fundação Boticário.**

Dir.: Beatrice Padovani Ferreira (UFPE, Brazil)

Co-Dir.: Dra. Rebecca Albright (Australian Institute of Marine Science, Australia)

Problems ...

Soluções (e problemas) a curto prazo !!

Equipamento u-CO₂ a
bordo do NHo. Cruzeiro do Sul
(ilhas oceânicas 2012)



Equipamento u-CO₂ em montagem
final no DOCEAN/UFPE
(operacional em jan./2014)



**Necessidade de técnicos especializados
(engenheiros) !!**

WP3.2 Mathematical modeling: Large scale (TA)

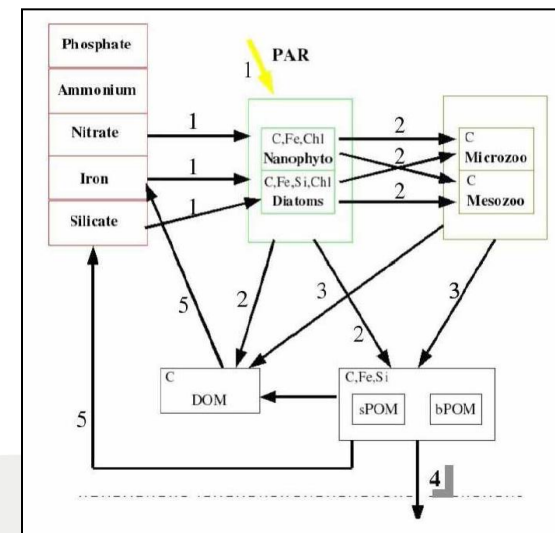
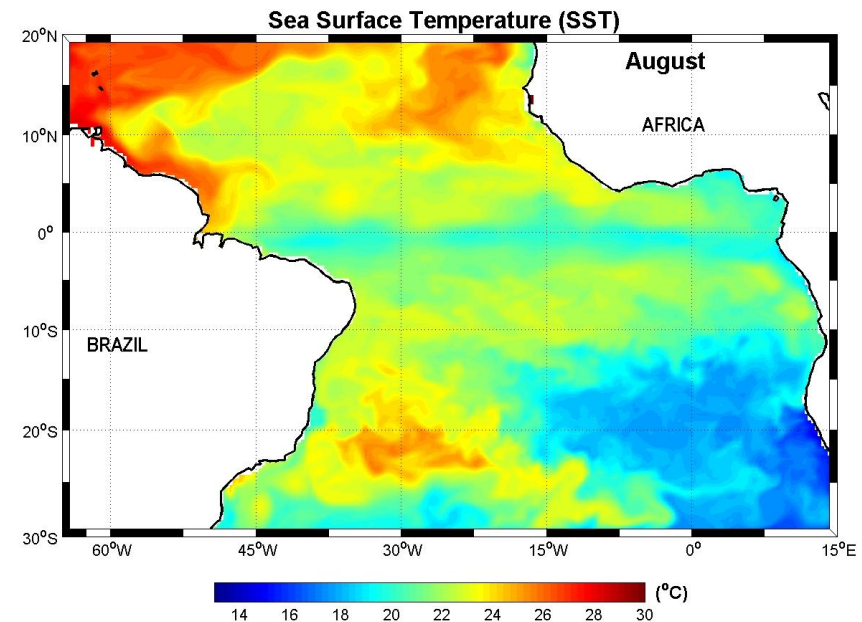
Modeling design

Physical model:

- ROMS_AGRIF (IRD/INRIA version)
- 1/12° + 40 NZ
- interannual 1990-2010
- 20 years climatological spin-up
- ETOPO2 + KPP
- COADS heat and fresh water fluxes + QuickSCAT wind stress
- ECCO database.

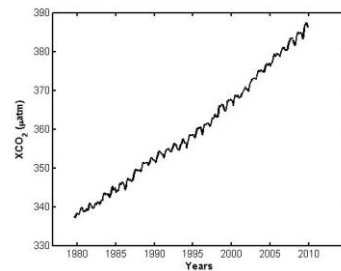
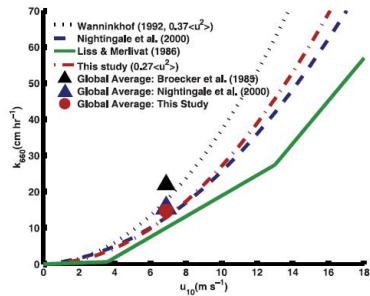
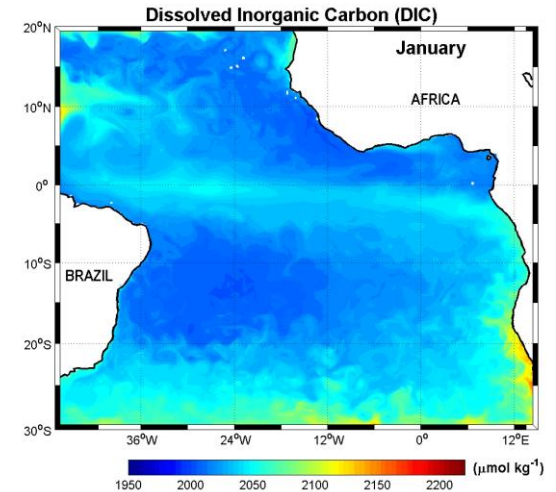
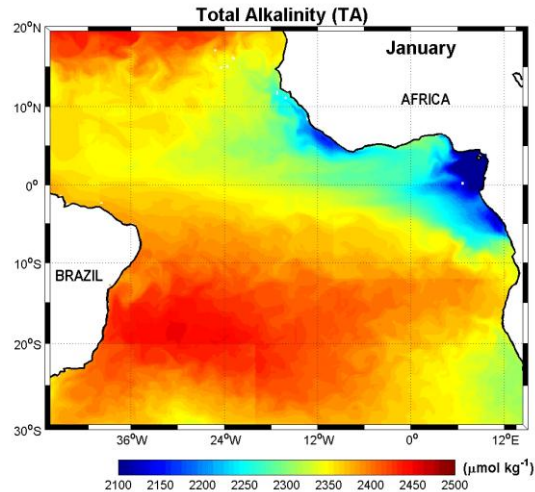
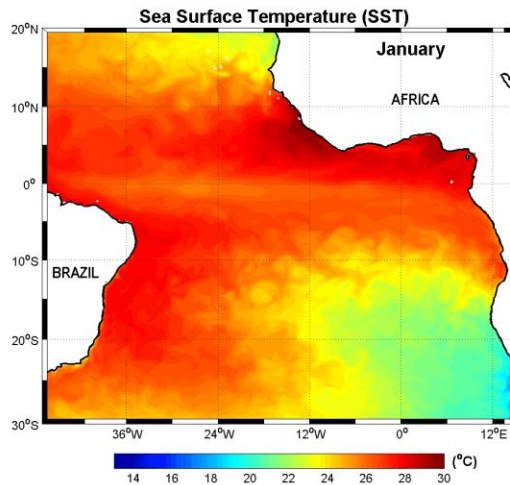
Biogeochemical model:

- PISCES routines (Aumont, 2005);
- Marine biological productivity and nutrient cycles (C-N-P-Si);
- World Ocean Atlas (WOAPISCES) to nutrient data;
- Chl-a SeaWifs.



WP3.2 Mathematical modeling: Large scale (TA)

CO2 Fluxes Forecast (2012-2100)

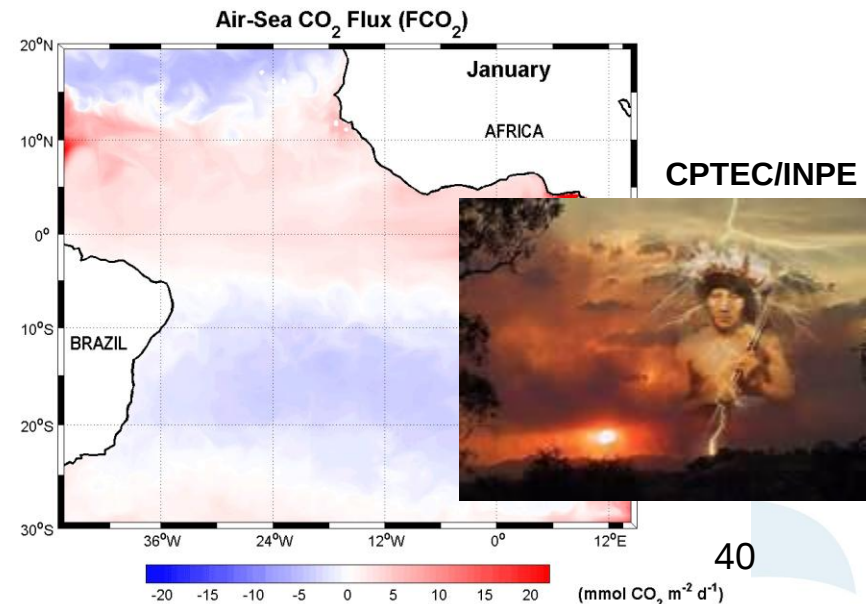


$$KCO_2 = g_1(u_{10}^2, Sc)$$

$$pCO_{2ATM} = g_4(PH_2O, XCO_2)$$

$$pCO_{2SEA} = g_3(SST, SSS, TA, DIC)$$

$$FCO_2 = KCO_2 \propto (pCO_{2SEA} - pCO_{2ATM})$$



PIRATA and INCT-AmbTropic: New CO₂ observing network in the tropical Atlantic

**M. Araujo , N. Lefèvre, P. Nobre , C. Noriega,
L. Bruto, R. Araujo**

**Centro de Estudos e Ensaios em Risco e Modelagem Ambiental - CEERMA
Departamento de Oceanografia – DOCEAN/UFPE**

**III Workshop Brasileiro de Mudanças Climáticas em Zonas Costeiras
Florianópolis-SC, 10-12 Dez 2013**