



# PIRATA

*Pilot Research moored Array in the Tropical Atlantic  
(1997 - 2008)*

*Prediction & Research moored Array in the Tropical Atlantic  
(2008 - ???)*

## Tripartite Programme

- FRANCE (IRD & Météo-France)
- BRAZIL (INPE & DHN)
- USA (NOAA/PMEL & AOML)



Photo: A.Kartavtseff

*By: Fabrice Hernandez (PIRATA SSG member) & Bernard Boulès (PIRATA SSG co-chair)  
IRD/LEGOS, France*





## Why PIRATA ?

PIRATA is motivated by fundamental scientific issues but also by societal needs for improved prediction of the climatic variability and its impact on the regional hydro-climates and, consequently, the economies of the adjacent land masses (e.g. West Africa, North-Eastern Brazil, the West Indies and the United States...).

### => Scientific goals of PIRATA :

- 1) improve the **description of the intra-seasonal to inter-annual variability** in the **atmospheric and oceanic boundary layers** in the tropical Atlantic (air sea fluxes, SST, heat content...);
- 2) **provide** a set of **data** useful for developing and improving the **predictive** models of the **ocean-atmosphere coupled system**;
- 3) document **interactions** between **tropical Atlantic climate** and variability **outside the region**, (e.g. ENSO, NAO etc...);

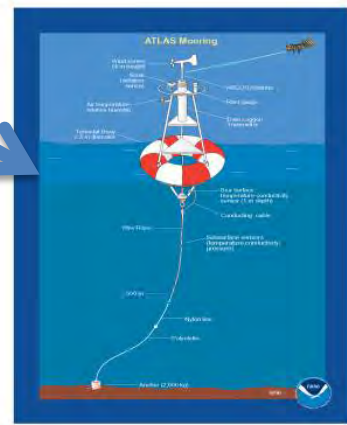
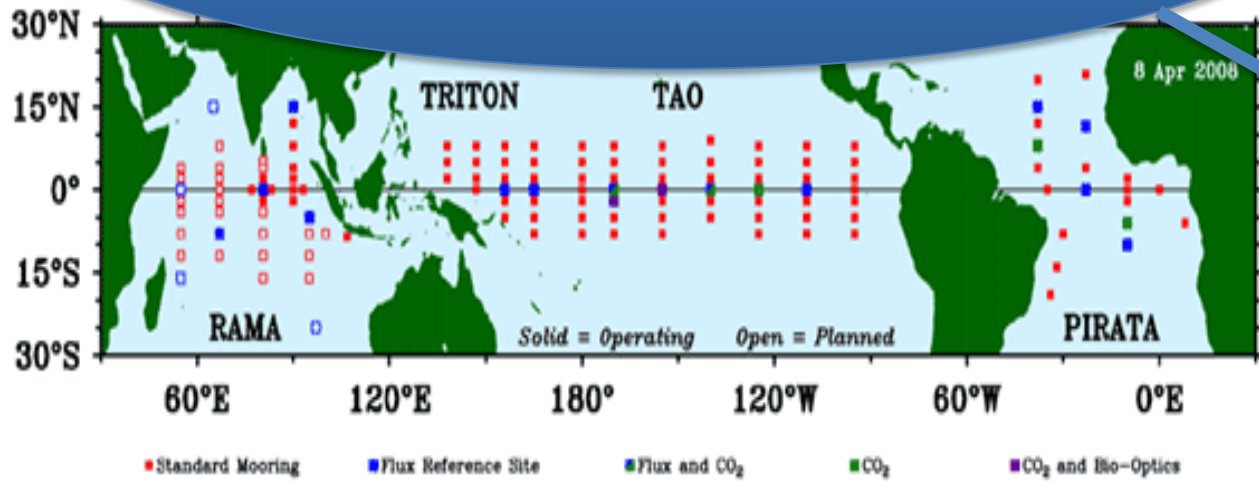


to meet these scientific objectives:

=> design, deploy, and maintain an array of moored oceanic buoys  
 + **collect** and **transmit** a set of oceanic and atmospheric data, via satellite in real-time,  
 (monitoring and study of the upper ocean and lower atmosphere in the TA).

=> What is PIRATA ?

Designed to measure:  
 Surface atm param:  $W_{dir/int}$  ;  $T_{air}$  ;  $H_{air}$  ;  $P$  ;  $Q_{sol}$   
 + Heat, moisture, momentum fluxes +  $Pres_{atm}$   
 Ocean param: 11  $T_{0-500}$  / 4  $S_{0-120}$  / 2  $Pres_{300-500}$   
 +  $U_{surf}$  +  $O_2$



# Evolution of PIRATA :

collaborative research between Brazil (INPE), USA (NOAA) & France (IRD & Meteo-France)

1) 1997-2001: “Pilot phase” : backbone array fully implemented :

- 10 “ATLAS” type moored buoys
- one current meter mooring at 0°N, 23°W :

1st MoU signed by the 5 involved organisms in 2001

Very first step and prior agreements:

*Each country committed to purchase the number of needed ATLAS systems:*

*USA (PMEL) purchased 10 ATLAS;*

*Brazil purchased 5 ATLAS:*

*France purchased 5 ATLAS:*

2) 2002-2006: “consolidation phase” + SW Extension in 2005:

⇒ to allow for a meaningful demonstration that the data would contribute significantly to both scientific research and operational applications



## Evolution of PIRATA :

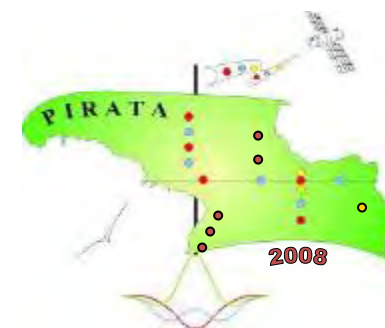
collaborative research between Brazil (INPE), USA (NOAA) & France (IRD & Meteo-France)

3) 2006: formal review and endorsement by CLIVAR & OOPC :

+ NE extension in 2006

+ Test of the SEE extension in 2006-2007

=> extension of the consolidation phase till February 2008



4) From 2008: “sustained phase”:

=> SW & NE extensions (begun in 2005) added to the PIRATA backbone

+ SEE extension maintained from 2013 and also added to the PIRATA network

***Pilot Research moored Array in the Tropical Atlantic***

***=> Prediction and Research moored Array in the Tropical Atlantic***

Also meteorological stations & tide gauges...

+ MoU regularly extended/renewed from 2001 (last extension signed in July 2014)



## How works PIRATA ?

### PIRATA structure & responsibilities sharing:

**1) PIRATA Resources Board:** => committee with one representative of each organism  
=> 1 from NOAA/USA ; 1 from INPE ; 1 from IRD/France & 1 from Meteo-France/France  
(+ invited)

The PIRATA Resources Board (PRB) is established with Terms of Reference (TOR).  
Its main tasks are :

- To **review** the **requirements** for the implementation of PIRATA;
- To **coordinate resources** that may be applied to the Program;
- To **encourage** scientific and technological **initiatives** in the participating countries to meet the objectives of PIRATA;
- To **report** on its activities to the Heads of the institutions providing resources.

**Yearly meetings** (*during the yearly international PIRATA meetings; generally organized Commonly with other programs, as AMMA, TACE, TAV group, next with PREFACE...*)



## How works PIRATA ?

### **PIRATA structure & responsibilities sharing:**

2) **PIRATA Scientific Steering Group**: 3 members of each country.

Its major tasks are:

- To **ensure** accomplishment of the **scientific** and **technical objectives** ;
- To **coordinate** the **technical** and **logistic support** necessary to maintain the array;
- To **ensure** the rapid **dissemination** of PIRATA **data** (in real-time where possible)...
- To **promote** the **utilization** of PIRATA data ;
- To evaluate, encourage, and **promote pilot extension projects** ...;
- To **coordinate with other** ongoing and planned observational efforts in the tropical Atlantic;
- To **invite collaborations** with other nations and institutions...;
- To **cooperate** with **international organizations** ; (eg CLIVAR Atlantic Panel, the GOOS/GCOS/WCRP OOPC, JCOMM..);
- To **report** regularly on **the status** of the PIRATA array and scientific results to the PRB, CLIVAR...

**Yearly coordination & scientific meetings** (*during the yearly international PIRATA meetings; generally organized commonly with other programs, as AMMA, TACE, TAV group, next with PREFACE...*)



## How works PIRATA ?

### **PIRATA structure & responsibilities sharing:**

3) **National coordinator:** 1 representative of each country, member of the SSG.

- Brazil: from INPE (with support by DHN for logistical/vessel aspects)
- USA: from NOAA
- France: from IRD (with close relationships with Meteo-France)

4) **PIRATA funding sources :**

Each country, through the 5 involved organisms, supports PIRATA.  
*(Dedicated commitments in the MoU).*

5) **PIRATA responsibilities sharing: (short summary)**

- NOAA/PMEL, Seattle: provide material for ATLAS systems, ensure ATLAS sensors calibration & ATLAS data dissemination;
- In Brazil (INPE, with DHN & UFPE): ensure ATLAS material transports from/to Seattle to/from ports of call; ensure yearly cruises for the Western buoys; ensure in situ data acquisition during cruises & data QC + dissemination + tide gauges/met stations on Islands;
- In France (IRD, with Meteo-France): same for Eastern buoys + tide gauge + ADCP moorings;
- In USA (NOAA/AOML, Miami): same for Northern buoys;

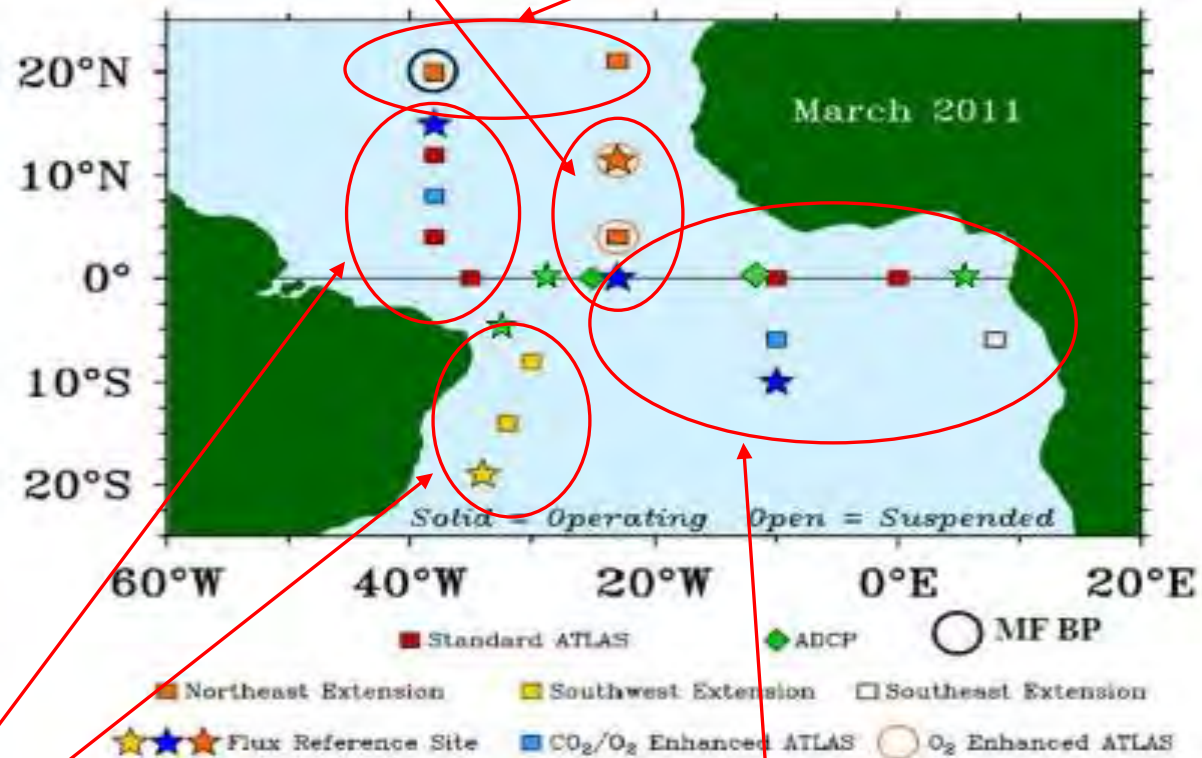


**PIRATA network servicing:**

**Maintained by USA** : 4 Atlas buoys : 2 deployed in 2006, at 4N & 11N/23W, 2 at 20N/23W & 38W deployed in 2007

18 ATLAS buoys from 2013

⇒ Yearly servicing from Research Vessels



**Maintained by Brazil**: 8 Atlas buoys  
5 from 1998,  
3 as the PIRATA SWE from 2005



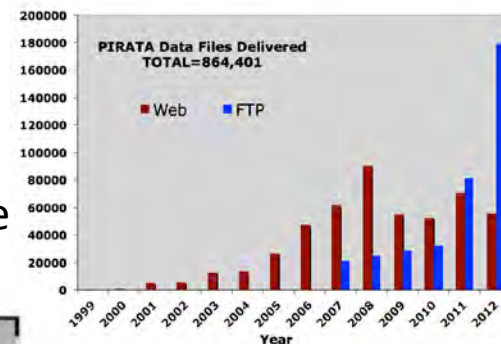
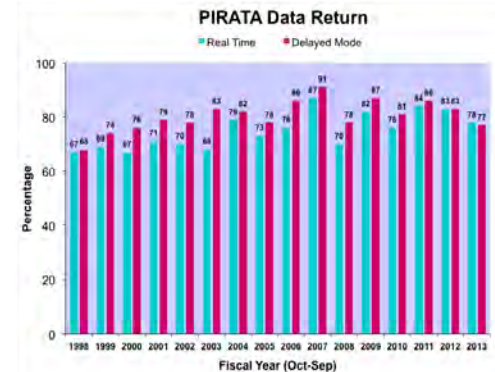
**Maintained by France** : 6 Atlas buoys  
5 from 1997

+ At 23°W-Equator : surface ADCP mooring since 2001;  
Buoy at 6S-8E deployed in 2006 - 2007  
(test period for a Southeastern Extension by South Africa & BCLME) then from 2013, thanks to the contribution of The EU PREFACE programme (purchase of a 2<sup>nd</sup> ATLAS buoy)  
Contribution by US & Germany for 23W-Eq site from 2006.

# PIRATA data: ATLAS buoys and cruises data

## ATLAS data => Real time & Delayed time:

- **PIRATA ATLAS data return over the period 1998-2013:**  
~>80% in average = similar to the Pacific TAO (before 2012...)
- **PIRATA files delivered over the period 1999-2013:**  
Through website & ftp : noticeable increase
- **Online best effort quality checked data dissemination policy**  
→ Real time transmission to GTS and GDAC for operational atmosphere and ocean centres  
→ QC PIRATA data integrated into reanalyses databases

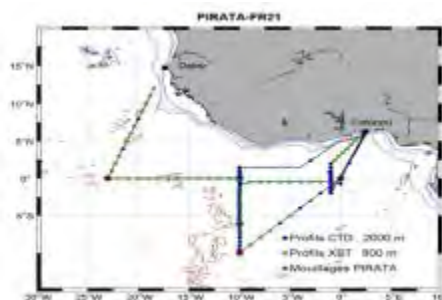
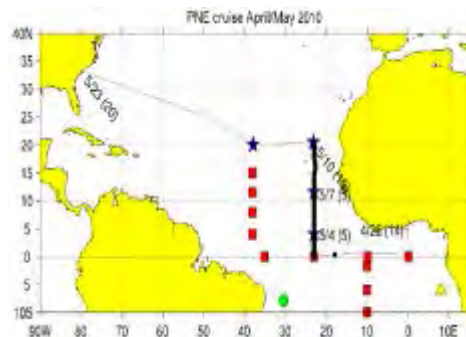
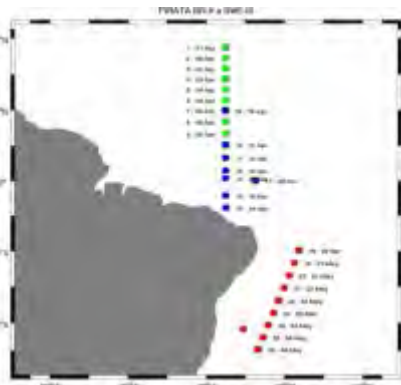


## YEARLY CRUISES => repeated sections (ctdo2/ladcp...)

38°W section: Brazil

23°W section: USA

10°W section: France



Yearly cruises = OPPORTUNITIES for: Deployment of ARGO profilers; surface drifters; CTDO2 & XBT: with possible transmission in quasi-real time for operational services Atmospheric measurements (Radiosoundings...) + « piggy-back operations »!

## Other operations/collaborations/observations from NOW to the FUTURE :

### Contribution to CO<sub>2</sub> parameters measurements (PI: N.Lefevre, IRD/Locean)

- from 2006 : 2 French « Carioca » systems at 8N-38W & 6S-10W transmitting in real time
- sea water sampling analysis during some Pirata cruises.

### Contribution to the acoustic Ocean Tracking Network (for Dalhousie University, Canada, F. Whoriskey)

- addition of OTN at 200m depth on each ATLAS lines -to follow sea mammals- in 2014

### Contribution to a USA/NSF program (PI: J.Moum, Oregon Univ.):

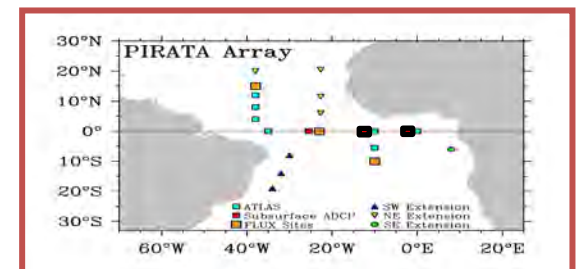
- 5 turbulence sensors (Chipods) installed at 23W and 10W-Equator (from 20 to 80m) from 2015 for 5 years. (2 already installed in 2014 for one year)

### Involvement/Contribution to the EU PREFACE (FP7-ENV, from 2013):

- Atlas SEE; ADCP mooring at 0-0...

### Involvement/Contribution to the EU AtlantOS program (H2020, from 2015):

- addition of Classical sensors (T/C, current, flux) to some particular sites (IRD)
- addition of one CO<sub>2</sub> sensor at PIRATA SEE (IRD)
- addition of O<sub>2</sub> sensors along 23W at 300m & 500m (GEOMAR)



# Capacity building in Africa related to PIRATA & collaborations with UFPE/Brazil

## - Capacity building in West Africa:

Regional Master 2 in « Physical Oceanography and Applications » initiated in 2008 at Cotonou/Benin by France in the « UNESCO Chair in Mathematical Physics & Applications » Of Cotonou (by IRD, Univ. Toulouse, collaboration/fundings TOTAL from 2009)

- => 60 African students from Benin, Togo, Cameroon, Ghana, Côte d'Ivoire, Nigeria, Senegal
- => 20 in PhD in France, Canada, Germany, Canada, South Africa (UCT) and Brazil (UFPE)
- => 4 in post doc

- Agreement between UFPE (Recife, Brazil), Univ. Toulouse (France) and Univ. Cotonou (Benin) => to reinforce capacity building efficiency & scientific collaborations & exchanges dedicated to The Tropical & South Atlantic basin studies

**INTERNATIONAL CHAIR IN MATHEMATICAL PHYSICS AND APPLICATIONS (ICMPA)**  
**UNESCO CHAIR IN MATHEMATICAL PHYSICS AND APPLICATIONS**  
 established in 2008 at the University of Abomey-Calavi (Republic of Benin)

**UNITW/UNESCO Chairs - Training networks and university networks** University of Abomey-Calavi

**MULTI-UNIVERSITY MASTER'S DEGREE AND DOCTORAL TRAINING PROGRAMME**  
**IN**  
**PHYSICAL OCEANOGRAPHY AND APPLICATIONS**

Considering the needs of capacity building in environmental sciences, climate and coastal environment, a regional master in "Physical Oceanography and Applications" is being organized by the International Chair of Mathematical Physics and Applications (ICMPA-UNESCO Chair) of the University of Abomey-Calavi at the Faculty of Sciences and Technology, involving the following universities, research institute and organizations:

Supranational Organization Committee (IOC) of UNESCO	Benin Institute University of Sciences	University of Abomey-Calavi (Benin)	IRD (France)	TOTAL (France)
<b>Dr Pierre Manderson</b> Co-ordinator and Head of the International Chair in Mathematical Physics and Applications (ICMPA-UNESCO Chair) UNESCO Chair in Mathematical Physics and Applications 17702 Paul Cotonou 01, Benin Tel: +213 44 98 48 41 Fax: +213 44 98 48 42 E-mail: pmanderson@unesco.org	<b>Prof. Théophile Bati</b> Co-ordinator of Physics and Mathematics in Oceanography and Applications (COMPA) 19 Avenue Hassan Doudou 1190 Cotonou 01, Benin Tel: +213 41 01 29 09 Fax: +213 41 01 21 29 E-mail: thbati@univ-abomey-calavi.edu.bj	<b>Prof. Mohamed Sartani</b> Co-ordinator International Chair of Mathematical Physics and Applications (ICMPA-UNESCO Chair) Centre de Recherches Physiques de Djamna BP 2130, 38111 Djamna, Algérie Tel: +213 21 38 10 27 / +213 91 84 38 38 Fax: +213 21 31 01 01 E-mail: sartani@univ-bordj.dz or: m.sartani@univ-bordj.dz	<b>Dr Bernard Blusseau</b> Co-ordinator of Physics in Oceanography and Applications (COMPA) Centre de Recherches Physiques de Djamna BP 2130, 38111 Djamna, Algérie Tel: +213 21 38 10 27 / +213 91 84 38 38 Fax: +213 21 31 01 01 E-mail: blusseau@univ-bordj.dz or: b.blusseau@univ-bordj.dz	<b>Mme. Yvonne Odette Bessis</b> DDMF/COMPA/ICMPA - TOTAL Rue Lavoisier 2, 92000 Nanterre La Défense Cedex, France Tel: +33 1 47 41 41 41 Fax: +33 1 47 41 41 41 E-mail: yodette.bessis@total.com

Official languages: English and French. English is the preferred choice, though, given the international dimension.

*As a conclusion:*

## *PIRATA contributes to Tropical Atlantic Climate and Ocean Forecast & Science*

- => PIRATA data sets are **increasingly valuable** for more **weather and climate forecasting**: used by **MyOcean** & **ECMWF** forecasting centres → **Copernicus** & medium range prediction
- ⇒ PIRATA became a major Atlantic **contribution** to the **global ocean observation system** in support of **climate, atmosphere, ocean sciences** (eg, GODAE, ARGO, GOOS, GOSUD, OceanSITES, AMMA, TACE, VAMOS, PREFACE...).
- ⇒ The PIRATA array and its extensions constitute the **main backbone of the Tropical Atlantic Observing System**
- +
- ⇒ PIRATA other observations (ADCP moorings, tide gauges...) & PIRATA **yearly** oceanographic **cruises** are sources of a **large number of measurements** along same sections & time series, + platform for “piggy-back” measurements (eg CO<sub>2</sub>);
- ⇒ PIRATA also constitutes an important tool & context for :
  - **international cooperations**, contribution to international/regional programs,
  - **capacity building** in developing countries (eg in Africa: regional Master 2 in Benin dedicated to “physical oceanography & applications”, PhDs, training at sea...)
  - **potential extensions** in the South Atlantic, in collaborations with Brazil & Africa

Thank you...