

PIRATA et le Service national d'Observation PIRATA en France : évolution des observations en Atlantique Tropical Est et perspectives

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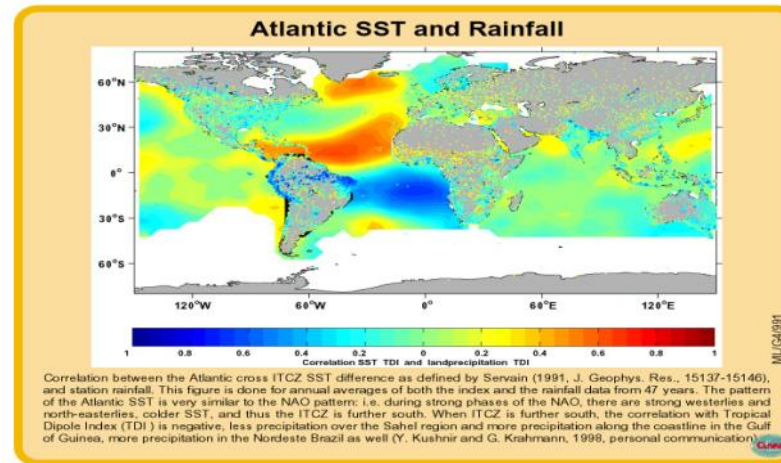


Photo: A.Kartavtseff



PIRATA in the Tropical Atlantic: why, who, what, how?

Why?



- fundamental scientific issues
- societal needs for improved prediction of the climatic variability and its impact on the regional hydro-climates.

⇒ MAJOR GOALS:

- 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;

PIRATA in the Tropical Atlantic: : what, why, who, how?

Who?

Initiated in 1996.... (by US, FR & BR colleagues)



PIRATA-1 Meeting
February 1996
Natal, Brazil

The Historic PIRATA Birth

10 years latter ...
Exactly at the same place

PIRATA 10 Years
Evaluation Workshop
February 2006
Natal, Brazil



PIRATA 1st buoy deployment:
September 10, 1997.

⇒ 2017: 20th anniversary
of the PIRATA network

⇒ Untill now, still a « tripartite » program sustained by:

USA (NOAA), **BRAZIL** (INDP, UFPE,DHN) & **FRANCE** (IRD, Météo-France, Ifremer, CNRS...)

Also collaborations with **Germany** (GEOMAR) from 2005-2006 (*AMMA, TACE, PREFACE...*).

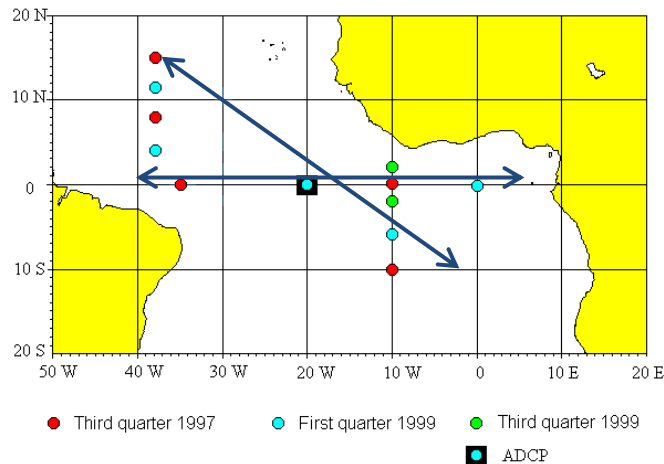
PIRATA in the Tropical Atlantic: : why, what, who, how?

What?

initially:

PIRATA = Pilot Research Moored Array in the tropical Atlantic

**was initiated in order to establish an observation network
to improve our knowledge and understanding
of ocean-atmosphere variability in the tropical Atlantic.**



*First PIRATA network
as drawn in 1996
in order to monitor the two
main modes of variability (equatorial & meridional)
in the tropical Atlantic*

PIRATA in the Tropical Atlantic: : what, why, who, how?

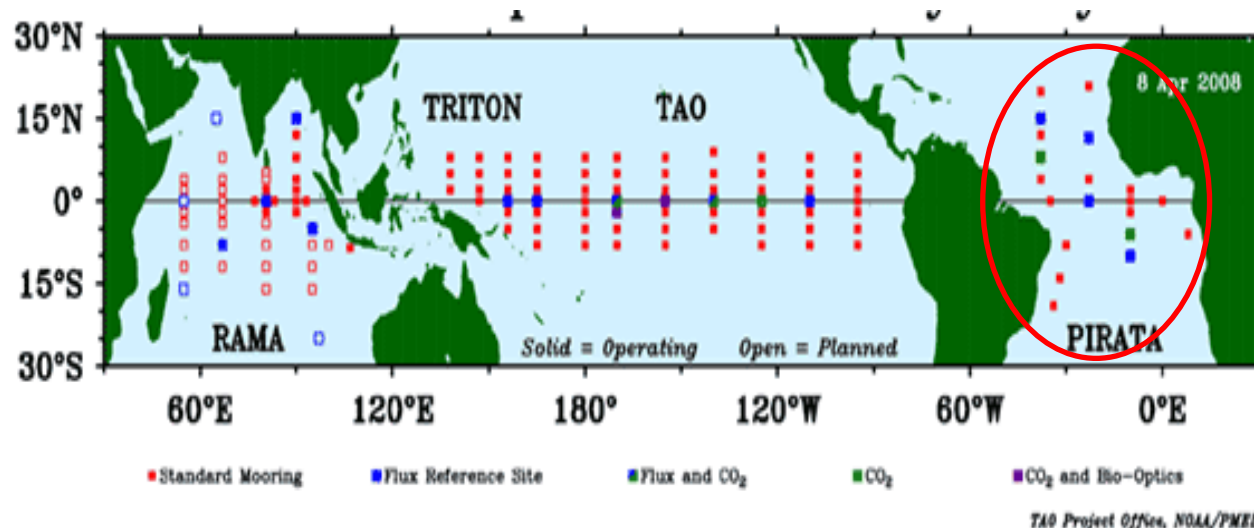
How?

to meet the 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.

=> PIRATA

= Atlantic contribution to the Global Tropical Moored Buoy Array



How?

PIRATA ATLAS buoys:

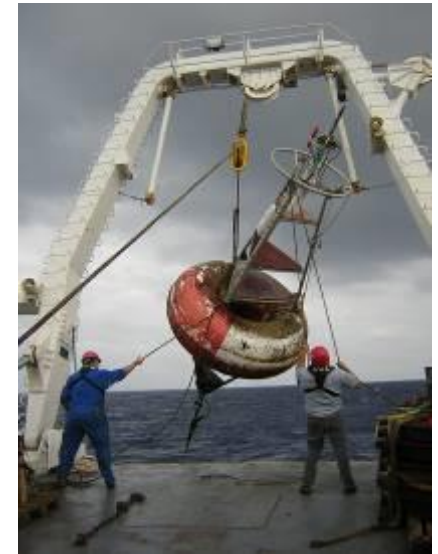
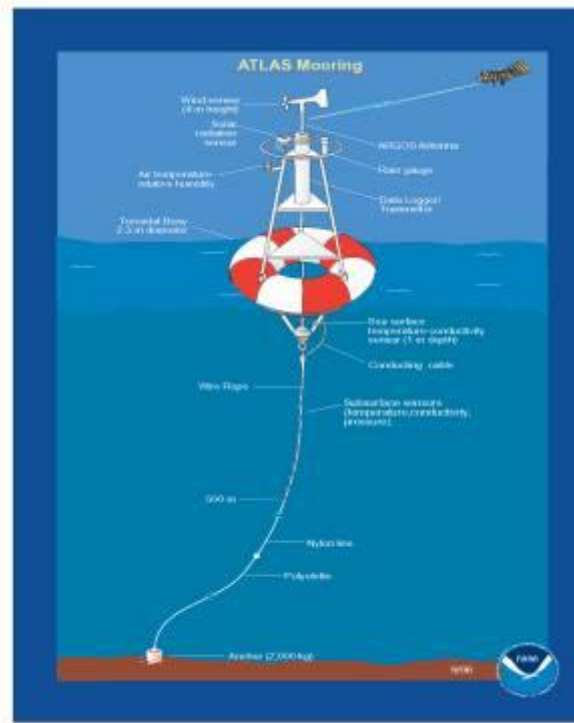
Measured Parameters :

Atmosphere:

- wind (direction, speed)
- relative humidity
- air temperature
- precipitation
- incident radiation

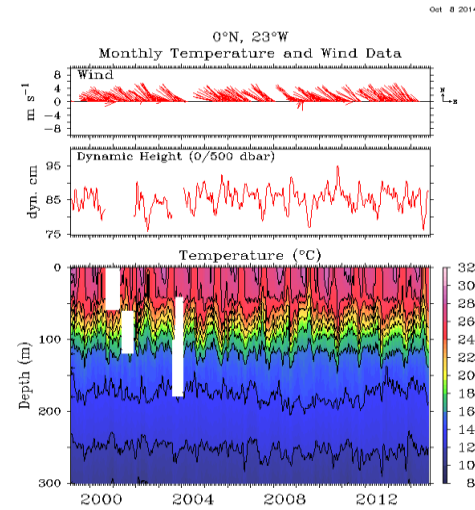
Ocean:

- temperature
(11 levels from surface to 500m)
 - salinity
(4 to 9 levels between 0 & 120m)
 - pressure (at 300 & 500m)
 - surface currents at 4 sites
-
- **Daily averaged data transmitted in real time by Argos;**
 - **High frequency data (10mn) available after servicing operations**



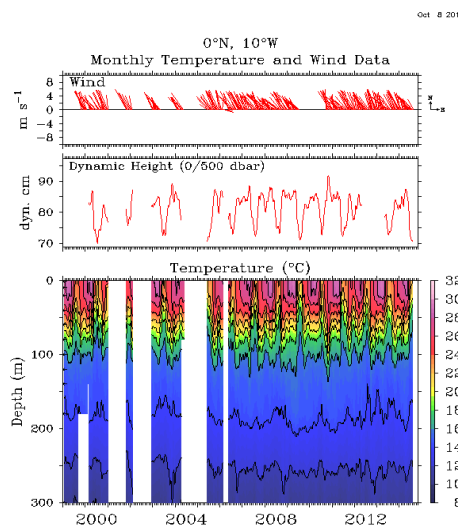
Examples of PIRATA ATLAS time series (6 buoys east of 23° W)

Eq-23° W



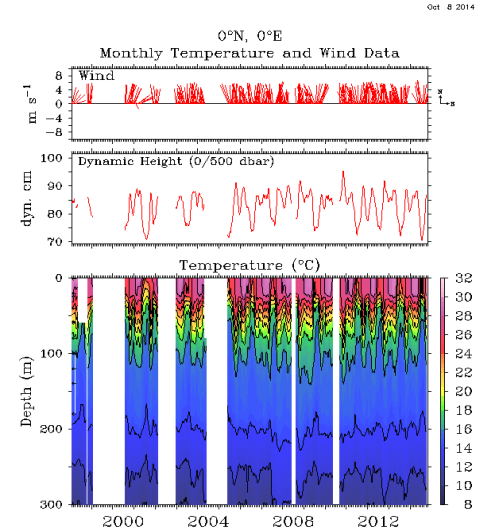
TAO Project Office/PMEL/NOAA

Eq-10° W



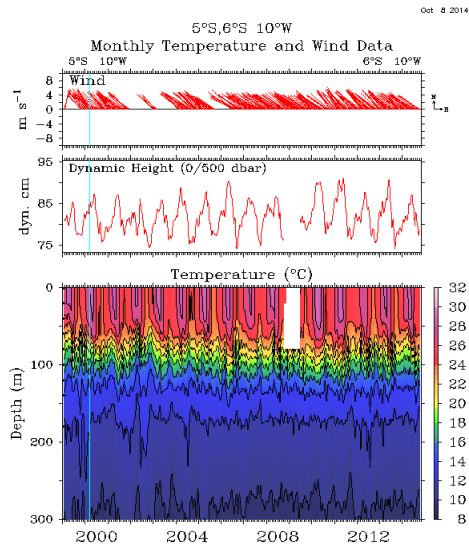
TAO Project Office/PMEL/NOAA

Eq-0° E:



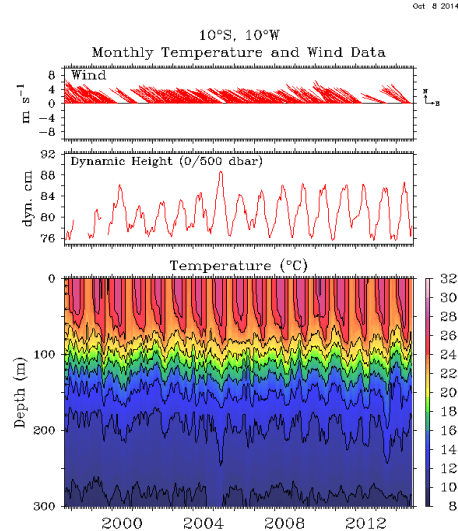
TAO Project Office/PMEL/NOAA

6° S-10° W



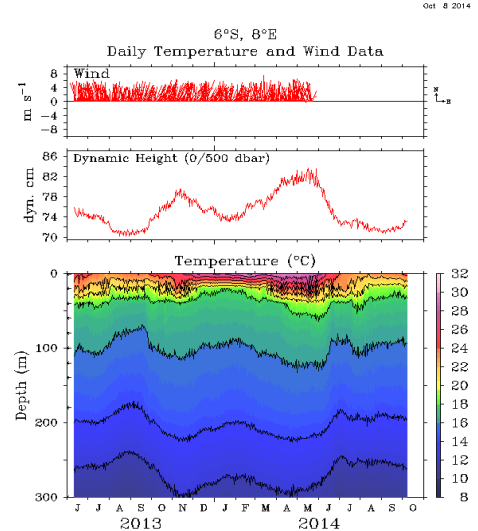
TAO Project Office/PMEL/NOAA

10° S-10° W



TAO Project Office/PMEL/NOAA

6° S-8° E:



TAO Project Office/PMEL/NOAA

Gaps either due to piracy activities (mostly 0 and 10W-Eq; none from 2008) or sensors failure

ATLAS data => Real time & Delayed time:

- PIRATA ATLAS data return over the period 1998-2015:

~>82% in average

- PIRATA files delivered over the period 1999-2015:

Through website & ftp : important need/demand

Open Data Policy

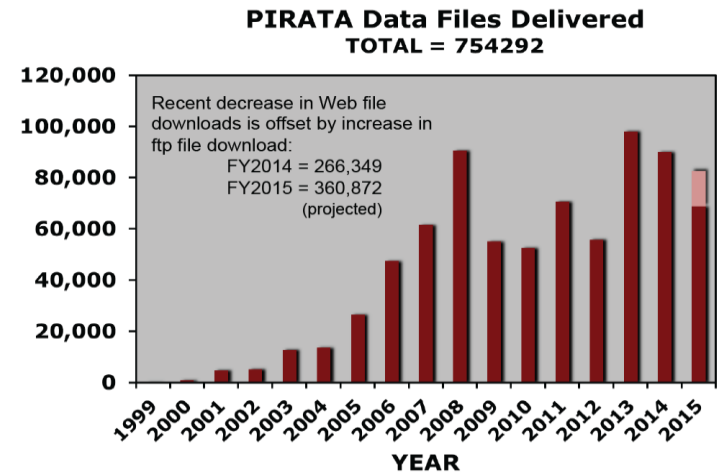
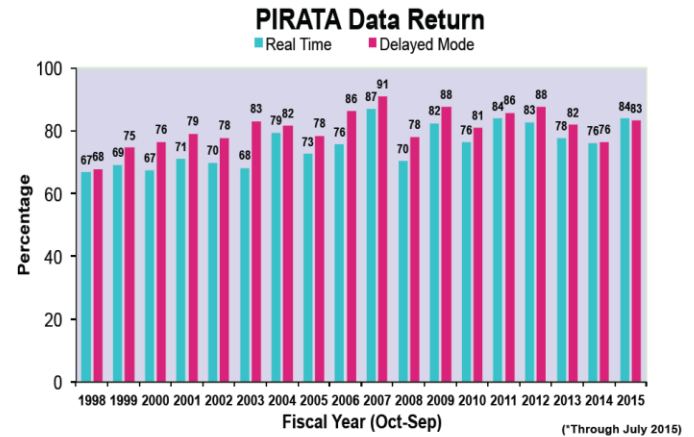


<http://www.pmel.noaa.gov/pirata>

<http://www.brest.ird.fr/pirata>

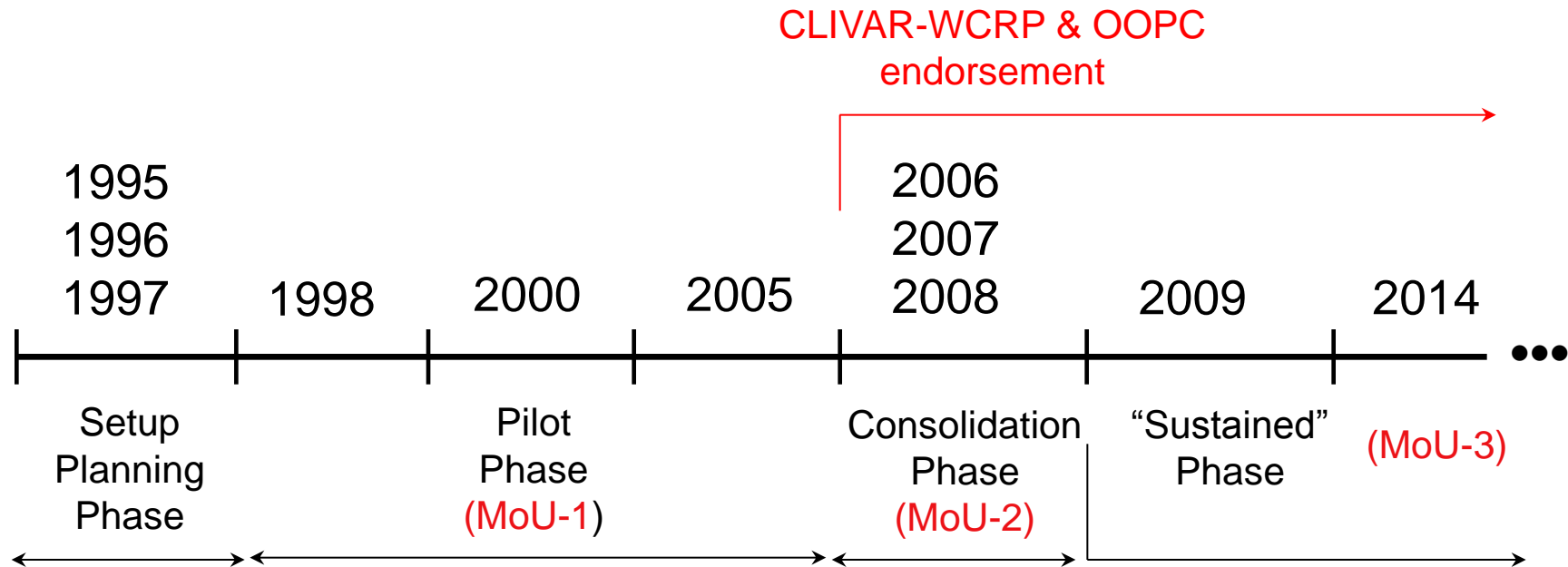
<http://www.pirata.ccst.inpe.br>

<http://www.aoml.noaa.gov/phod/pne/cruises.php>



How PIRATA can work : different “phases”

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



Commitments of partners through a MoU very important...



=> The PIRATA network at now :

18 meteo-oceanic buoys

3 ADCP moorings (0-300m)

6 Flux Reference sites

2 with surface CO₂ sensors

2 with O₂ subsurface sensors

1 with P_{atm}

Maintained by Brazil:

8 Atlas buoys:

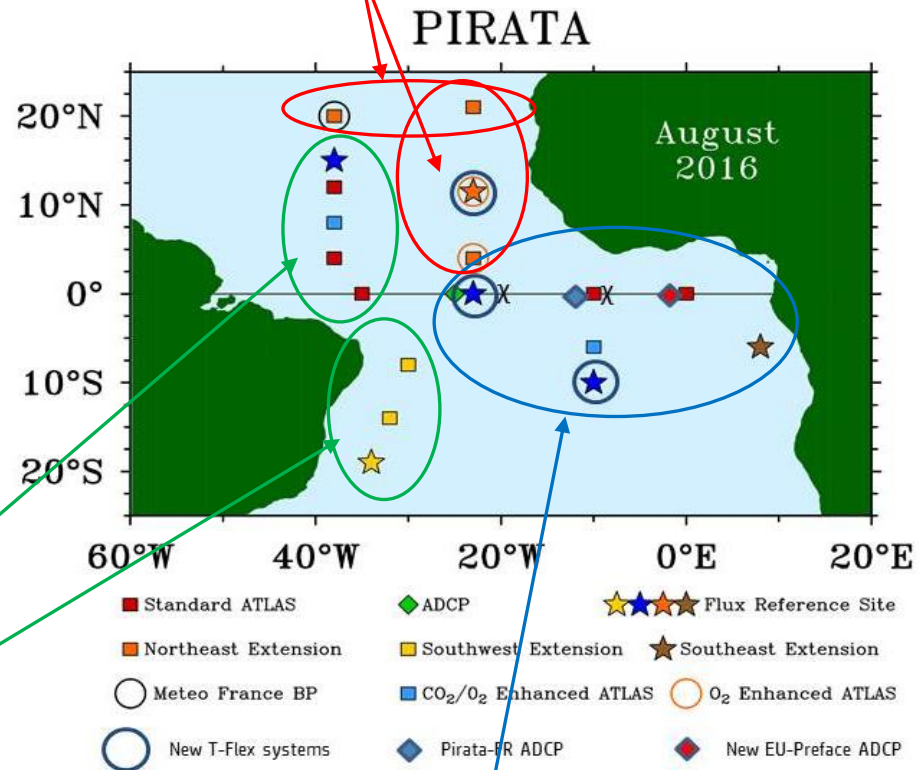
5 from 1998,

3 as the PIRATA SW Extension from 2005



Maintained by USA : 4 Atlas buoys :

PIRATA NE Extension from 2006



Maintained by France :

6 Atlas buoys:

5 from 1997-98

+ PIRATA SE Extension at 6S-8E

in 2006 – 2007 (by South Africa & BCLME)

then from 2013 (EU PREFACE programme)

+

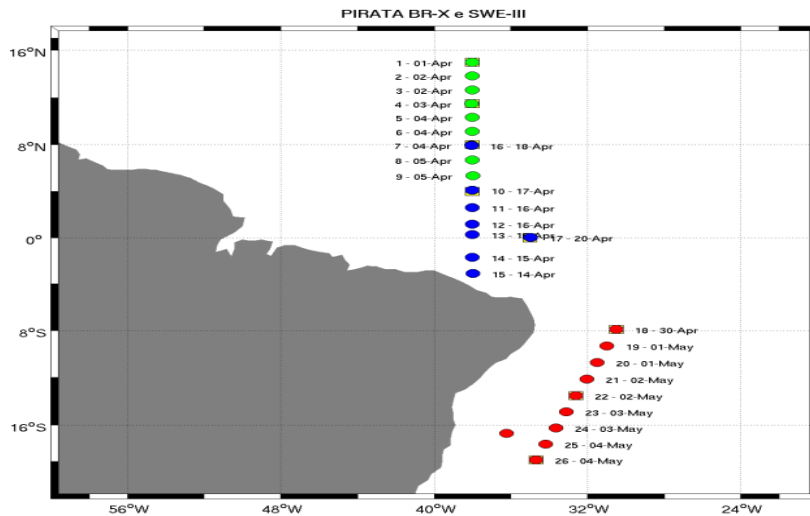
3 ADCP moorings (23°W, 10°W & 0°E along the equator);

Contribution by US & Germany for 23W-Eq site from 2006.

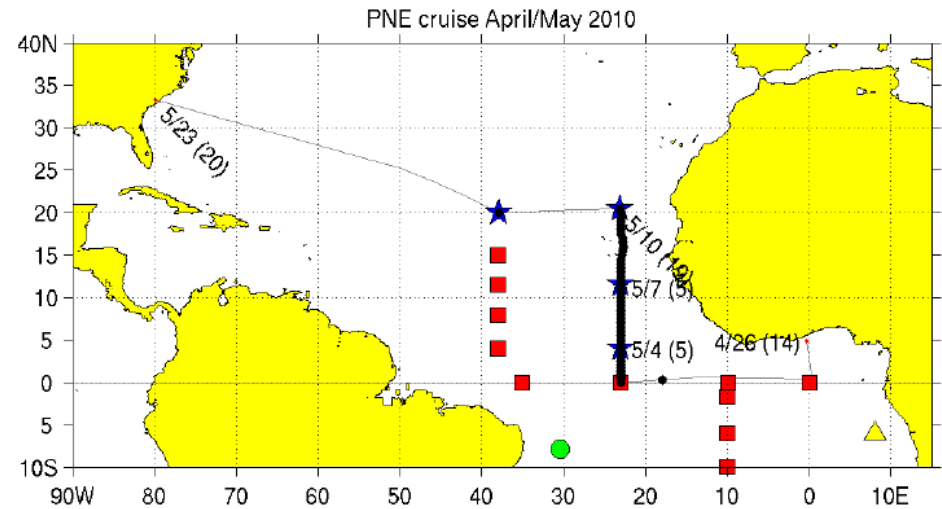
Network servicing:

YEARLY CRUISES => repeated sections with CTD profiles

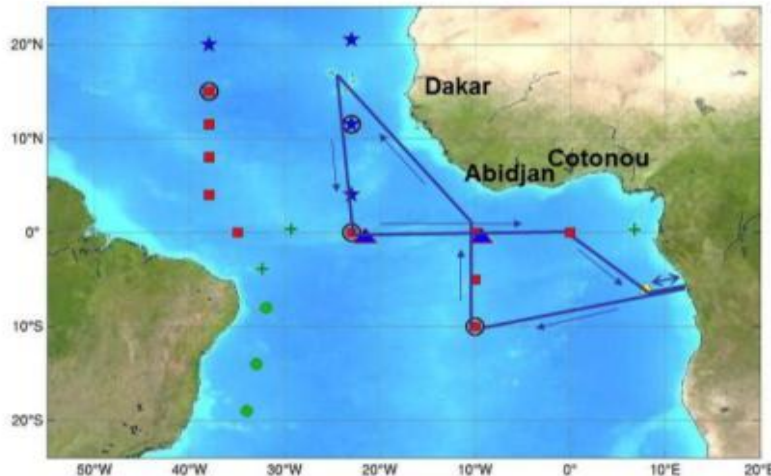
38°W section: Brazilian cruises



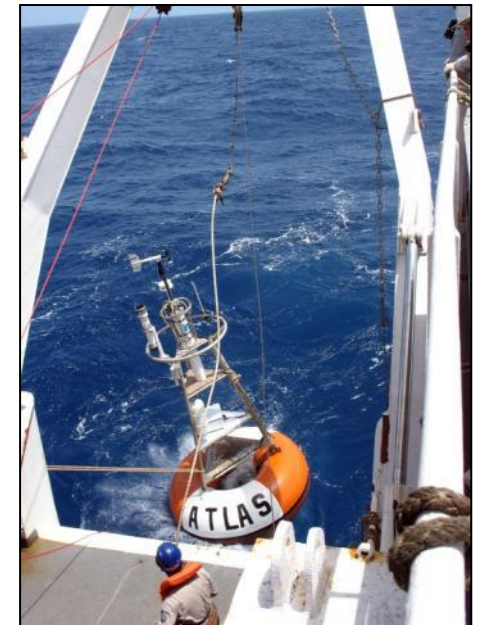
23°W section: US cruises



10°W section: French cruises



≥ 40 days each



Progressive enhancement of measurements acquired thanks to PIRATA,

with focus in the Eastern tropical Atlantic during PIRATA-FR cruises

- 1) Essential Oceanic Variables (temperature, salinity, currents) measured from the first steps of PIRATA during the cruises & from the buoys (but current, only on a few ones)
- 2) Buoys & cruises = platforms to get more data sets & contribute to some other programs.

e.g.:

Quasi real time data (CTD, XBT) for operationnal services

ARGO profilers deployment

SVP (SVPS, SVPB) deployment

Biochemistry measurements

+ opportunity operations, e.g.:

Gliders experiments (Pirata-FR in 2011, with GEOMAR)

Atmospheric measurements (Radiosoundings...)

...



reinforce and maintain needed observations in the Gulf of Guinea

Following PIRATA & CLIVAR (TACE) scientific requirements/recommendations

Upper layer equatorial currents:

From 2001: 1 ADCP mooring maintained at 23°W-0°N

⇒ From 2005: a 2nd ADCP mooring maintained at 10°W-0°N (by IRD)

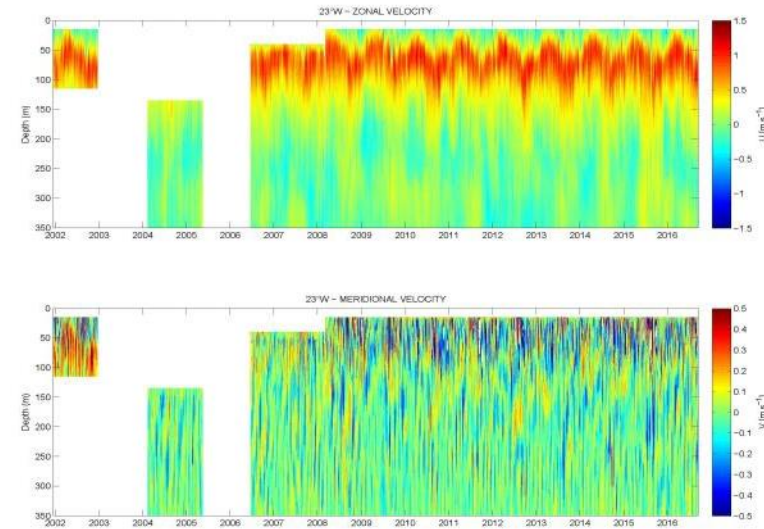
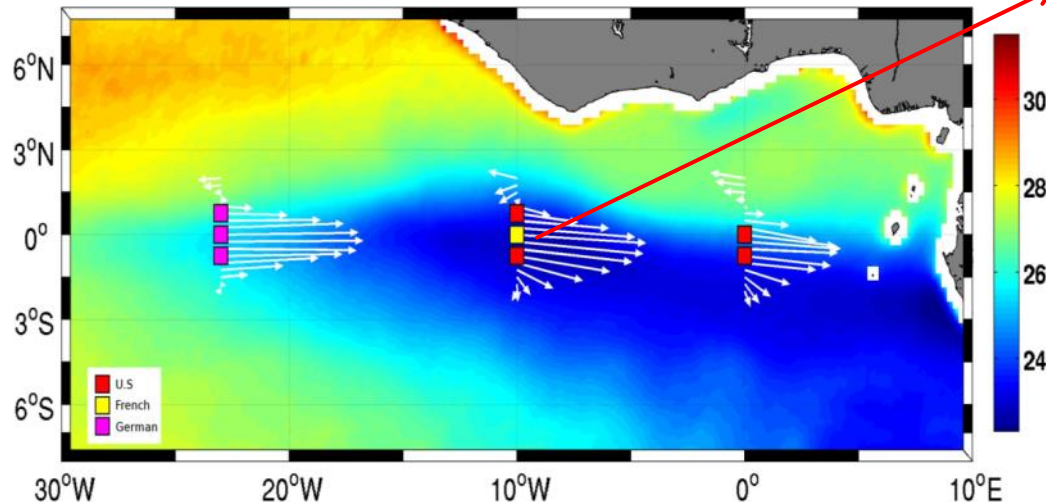
in the frame of EGEE/AMMA then PIRATA-Fr

⇒ From 2016: a 3rd ADCP mooring at 0°E-0°N

in the frame of PREFACE & PIRATA-Fr

⇒ 3 equatorial ADCP moorings:

⇒ 23°W-10°W-0°E ⇒ EUC monitoring,
SEC/EUC vertical shear, waves,...



2001-2016: J.Habasque, IRD

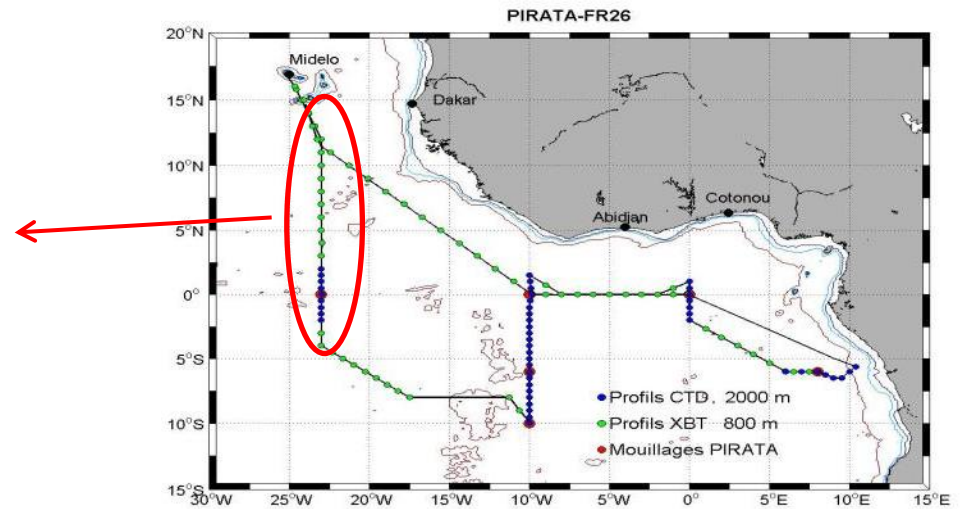
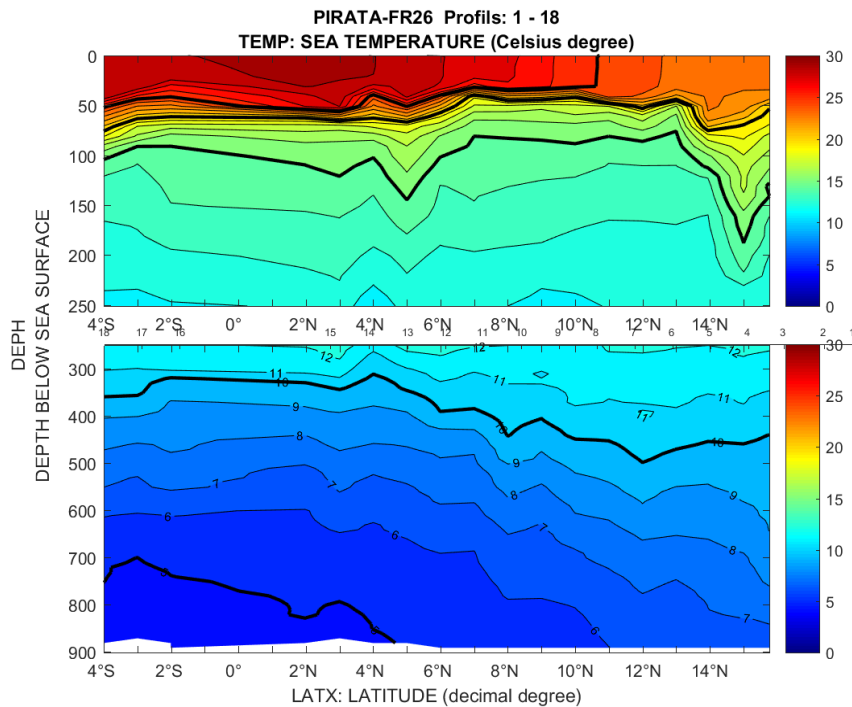
(Kolodziejczyk et al., 2009; Johns et al., 2013; Perez et al., 2014...)

From 2003: deployment of XBT in the eastern Tropical Atlantic

Profiles transmitted in quasi-real time (daily) to **CORIOLIS** (along with CTD profiles)

Contribution to **MERCATOR / GODAE**

From 70 to 100 profiles during yearly French cruises.



J.Grelet, IRD-Brest

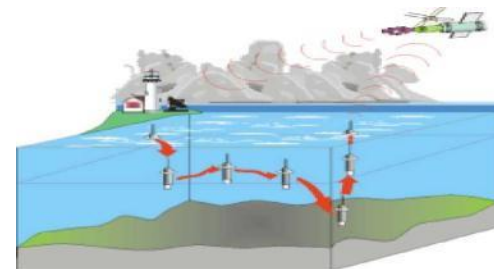
From 2003 : deployment of ARGO profilers in the eastern Tropical Atlantic

Contribution to ARGO, through CORIOLIS.

About 6-8 deployments during yearly French cruise.

~ 90 profilers deployed from 2003

=> Data in poorly documented regions (Southeast)



April 2013



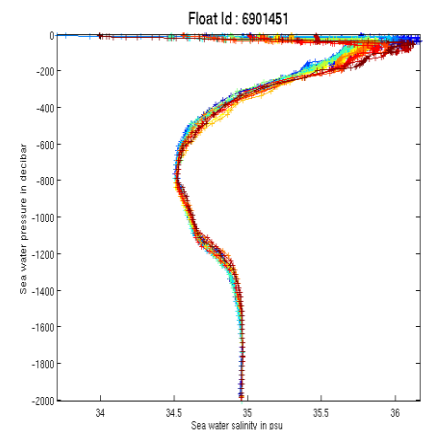
Sept 2013

Vertical resolution:

0-100m = 1m

100-200m = 5m

200-2000m = 25m



From 2013 : ARGO profilers with enhanced vertical resolution (1m)

From 2016: profilers with « double » programming

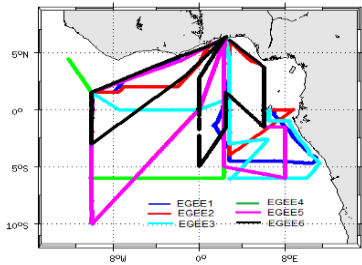
In 2017: profilers with O2 sensors

=> need of T/C measurements for ARGO profiles validation down to 2000m

=> All CTD-O₂ profiles are down to 2000m depth during all PIRATA-FR cruises.

From 2004: measurement of nutrients in the eastern Tropical Atlantic

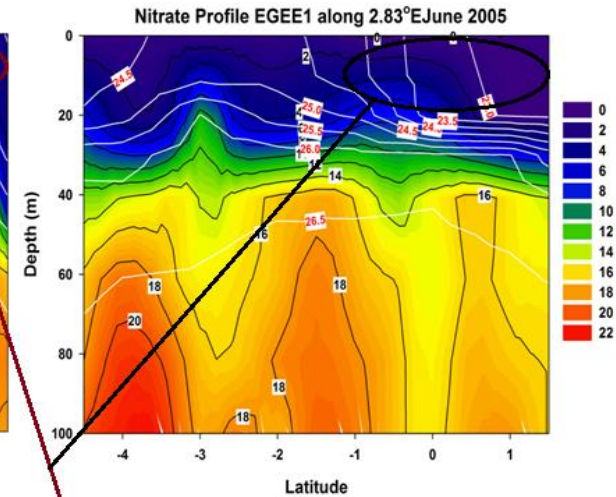
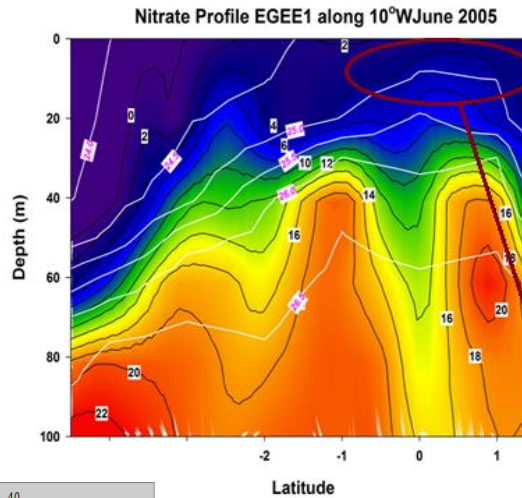
(Nitrates, Nitrites, Phosphates, Silicates)



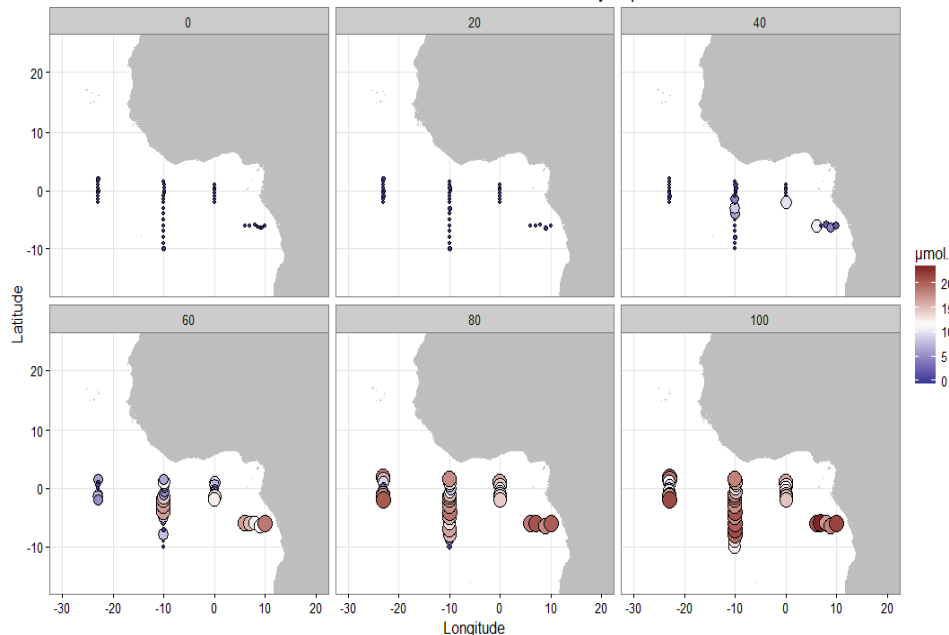
Surface samplings along the trackline (every 1° - 2°)

Samplings along the vertical during CTD/O2 casts

(F.Baurand, IRD-Brest)



PIRATA-FR26 - Nitrates concentration by depth



Examples:

Up: Nitrate ($\mu\text{mol/kg}$) sections in June 2005 along 10°W and 3°E (from Nubi et al., 2016)

Down: Nitrate ($\mu\text{mol/kg}$) distribution at different depths In March-April 2016 (Habasque, IRD-Brest, pers. comm.)

Also: Fluorescence with Wetlab ECO FL sensor during CTD-O2 casts.

Surface salinity measurements along the trackline for Tsgraph data validation (**COROLIS & GO-SHIP**)

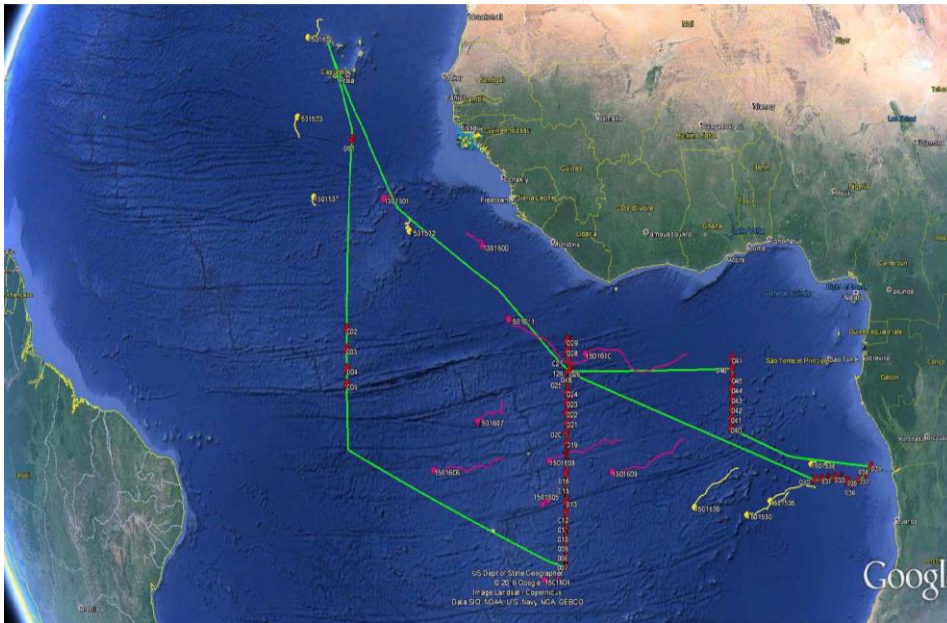
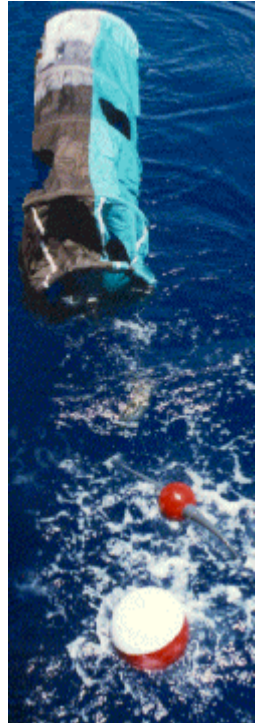
From 2005: Deployment of surface profilers in the eastern Tropical Atlantic

(SVP, SVP-B, SVP-BS)

Contribution to Global Drifter Program (GOOS).

From 5 to 15 deployments per yearly French cruise.

Through CNRS/INSU, Meteo-France, etc (& contribution to AtlantOS)



*Example:
Trajectories of the 21 SVP-B
from their launch in March 2017
during PIRATA FR27,
as contribution to AtlantOS & NOAA GDP
(date: June 15, 2017; M. Le Garrec, pers. comm.)*

From 2006: acquisition of CO₂ parameters

1) CARIOCA systems added at the buoys located at 6°S-10°W (from 2006) at 8°N-38°W (from 2008) & at 6°S-8°E (from 2017; AtlantOS).

2) Surface samplings along the tracklines (every 1°- 2°) for TCO₂, TA

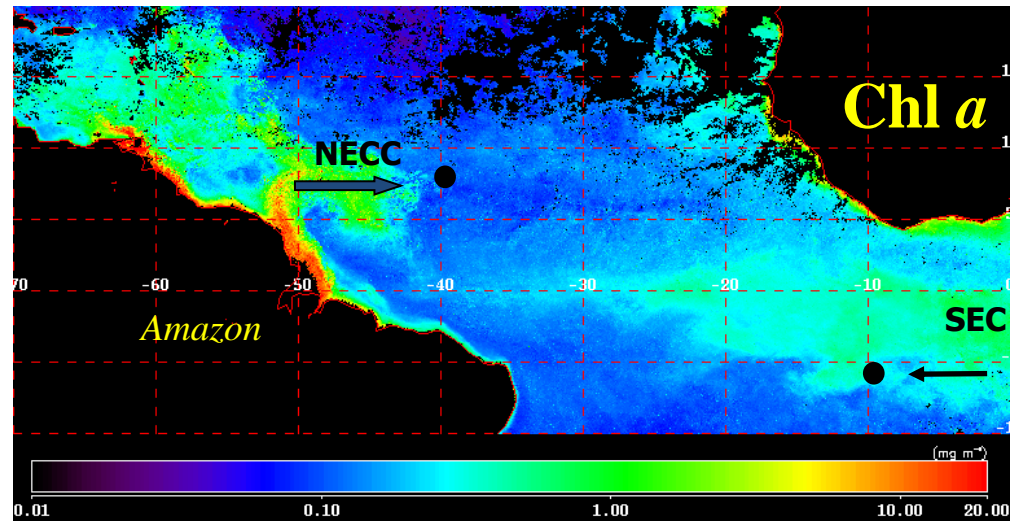
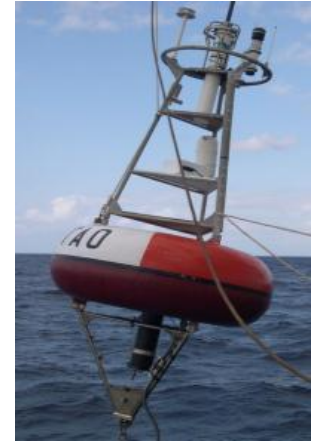
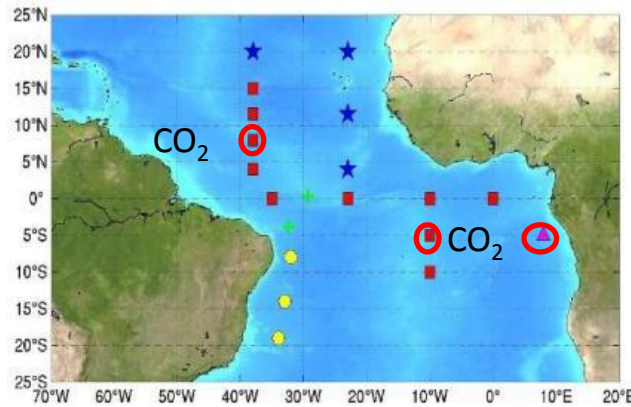
Samplings along the vertical (0-100m) during CTDO₂ casts at the buoys

=> Amazon & Congo influences?

PI: N.Lefèvre (IRD, Paris)

As part of PIRATA.

Contribution to CARBOOCEAN &
CARBOCHANGE

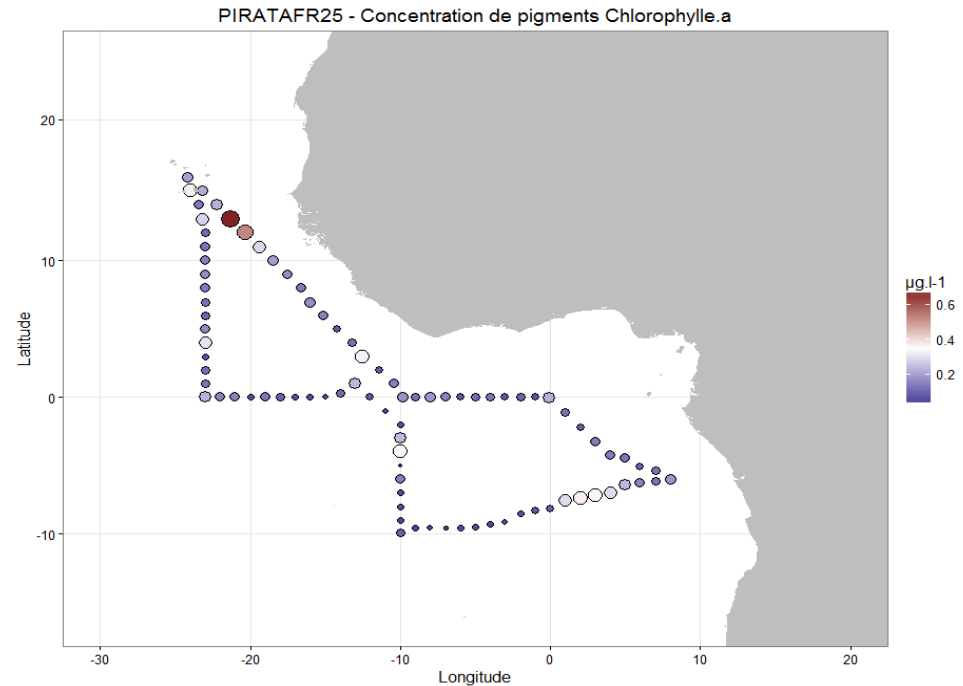
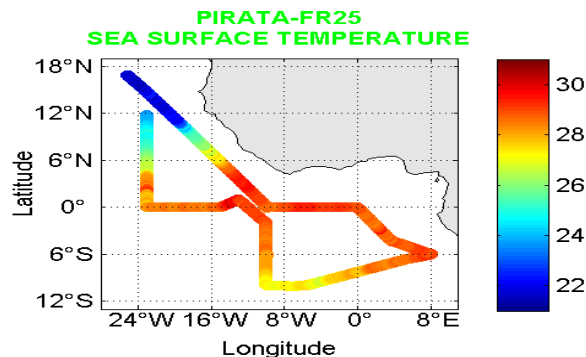
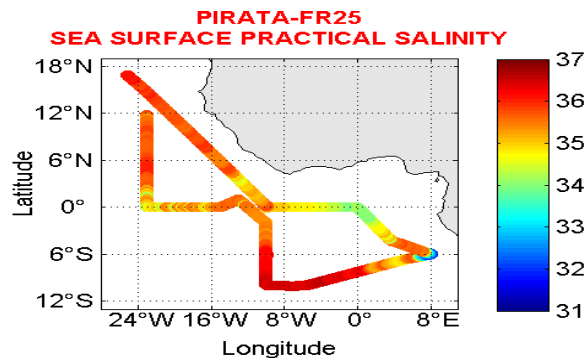


From 2011: Acquisition of Chl pigments (HPLC) in the eastern Tropical Atlantic

Surface samplings along the trackline (every 2°)

Samplings along the vertical during CTDO₂ casts

(S. Hillion, IRD-Brest)



Examples:

Up: Surface Chl pigments concentration during the PIRATA FR25 cruise -March/April 2015- (J.Habasque, IRD-Brest)

Left: surface SSS & SST along the PIRATA FR25 trackline (J.Grelet, IRD-Brest)

From 2015 (but depending upon the research vessel equipment):

Acoustic measurements

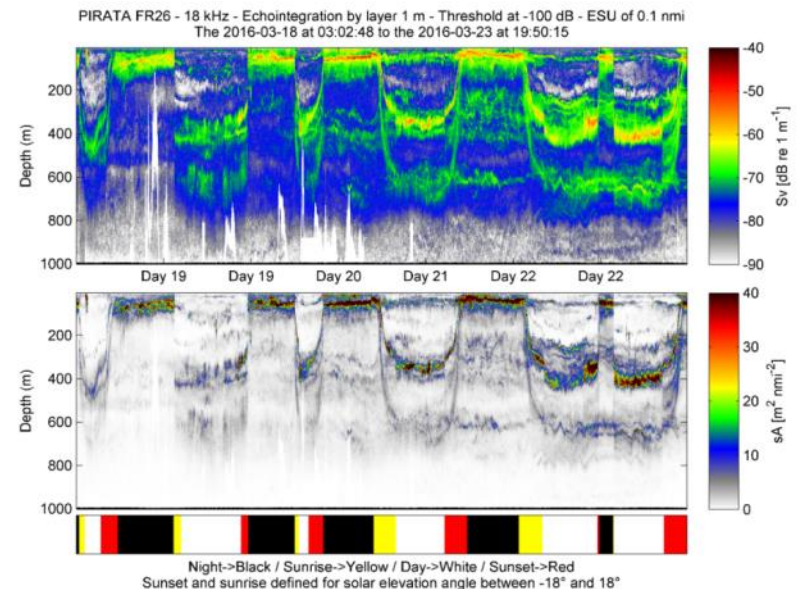
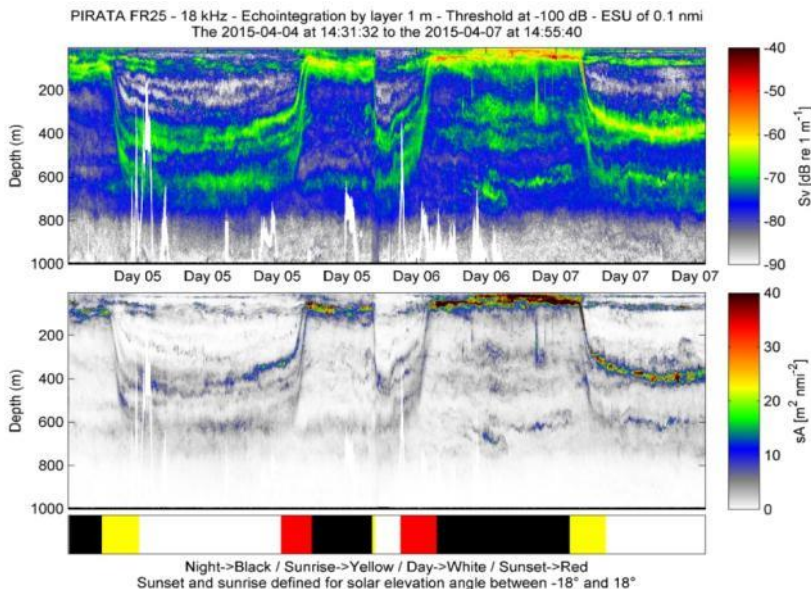
R/V Thalassa =>

Multifrequency acoustic data (18, 38, 70, 120, 200 and 333 kHz)
=> information on biotic and abiotic ecosystem components.

=> Analysis of the pelagic organism spatial organization, the planktonic biodiversity, as well as upper trophic level marine organisms in relation with ocean conditions in contrasted regions (fronts, upwellings, currents shear...) + diel vertical migration.

2015

2016



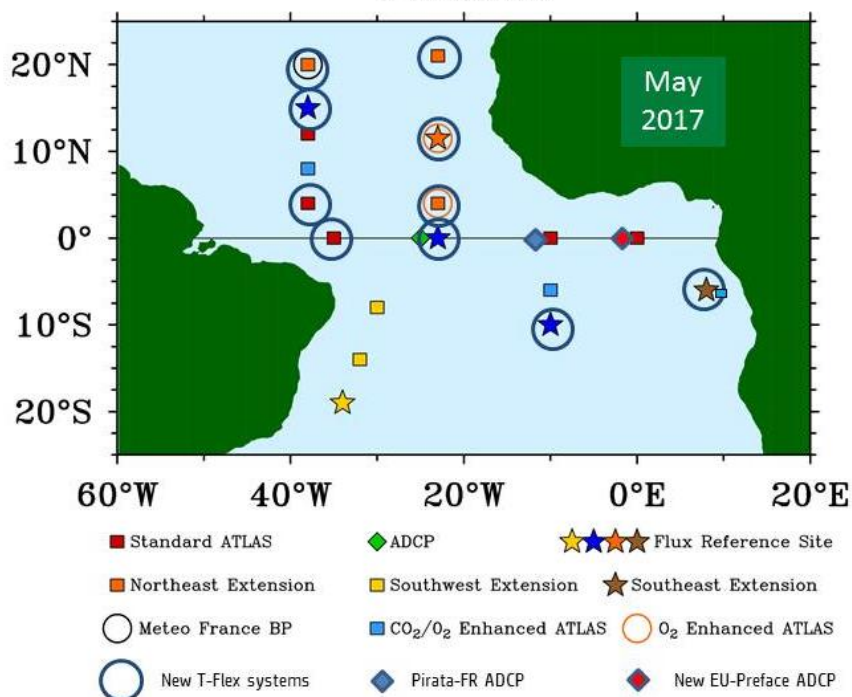
South

North

(J.Habasque, IRD-Brest)

Present (from 2015) & short term enhancements

PIRATA



From 2015:

Progressive replacement of ATLAS system

By T-FLEX systems:

⇒ More real-time data (Iridium transmission)

⇒ Potentially more sensors

- 7 T-Flex at now, 10 T-Flex by July 2017

Data available on:

<http://www.pmel.noaa.gov/pirata/tflex/>

In the frame of the AtlantOS : enhancements from 2017

- 3 currentmeters at 10W-0N, 38W-8N & 35W-0N (at 10m) (IRD/LEGOS)
- 2 T/C at 10W-0N (at 5m & 10m) (IRD/LEGOS)
- O2 at 23W-4N and 23W/11.5N with RT data transmission (GEOMAR)
- CO2 at 8E-6S (IRD/LOCEAN)

and also...: Sargassum algae observation & samplings (from 2011)

often encountered off West Africa within eastward flows,

sampling (for taxonomy, biological & possibly microplastic analysis).

large area of Sargassum on which large amount of plastic objects can be observed...



Pictures: Frédéric Marin March 2017



Concluding remarks (& about the future of PIRATA...):

- PIRATA is recognized as *“the backbone for observations in the Tropical Atlantic for both climate research and operational climate and ocean prediction”* (CLIVAR)

enhancement demands (AtlantOS, CLIVAR, OOPC, ...toward OceanObs2019):

e.g. biochemistry sensors, aerosols, O₂, CO₂, currents, fluxes, time series in the South...

To keep in mind :

- vessel time, funding resources & human power limited (*some are decreasing!...*)
- data still « sleeping »... or not validated yet (*human power!...*).

⇒ PIRATA review process as part of Tropical Atlantic Observing System Review:

Will begin in November 2017; White paper expected as input to the review.

⇒ **NEED INPUTS/INFOS from the operational community (ocean, climate) about Real Time Observations assimilation impacts**

The French SNO works with very few people & needs more support & human power,
+ involvements (use of in situ data & their « valorization »)
to be efficiently sustained on the long term...

NEXT PIRATA MEETING (20th anniversary...) along with PREFACE/TAV:

[History](#) [Sessions](#) [Committee](#) [Schedule](#) [Events](#) [Guide](#) [Venue](#) [Contact](#) [Home](#) [About](#) [Abstracts](#)



PIRATA 20 Years

November 5 – 10, 2017

Fortaleza, Ceará - Brazil

MERCI / THANKS / OBRIGADO

PIRATA data management

ATLAS meteo-oceanic buoys:

- transmission and available in real time (24h averaged & transmission every 24h)
- validated data, a few months after yearly servicing (high frequency data)

<https://www.pmel.noaa.gov/gtmba/pirata>

& New T-FLEX buoys at 3 PIRATA sites (1h averaged & transmission every 6h)

<http://www.pmel.noaa.gov/pirata/tflex/>

YEARLY CRUISES data:

French site: <http://www.brest.ird.fr/pirata/>

with access to data (CTD, ADCP, chemistry,...)

US site: <http://www.aoml.noaa.gov/phod/pne/>

Brazil site: <http://pirata.ccst.inpe.br/en/home/> *(all raw data sets;
data treatment expected by 2017, INPE & UFPE involved)*

CO₂ data : through SOCAT & CDIAC databases; international CO₂ community protocol.

O₂ data : in “quasi” real time is planned at term at GEOMAR.

Additionnal info about PIRATA French cruises & data:

- All PIRATA cruises have a D.O.I.; <http://dx.doi.org/10.18142/14>
- S-ADCP data have a D.O.I. (2007-2016); <http://doi.org/10.17882/44635>

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

=> *Major tasks:*

- 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.*

- 2) **PIRATA Steering Scientific Group:** *3 members of each initial country (Br, Fr, USA)*
+ 1 of Germany (GEOMAR, from 2008).

=> *Major tasks :*

- To ensure accomplishment of the scientific and technical objectives ;*
- To coordinate the technical and logistic support necessary to maintain the array;*
- To invite collaborations with other nations and institutions...;*
- To cooperate with international organizations ;*

Good & efficient collaborations & cooperation => possible enhancements!