



# PIRATA et SNO PIRATA : évolution des observations en Atlantique Tropical Est et perspectives

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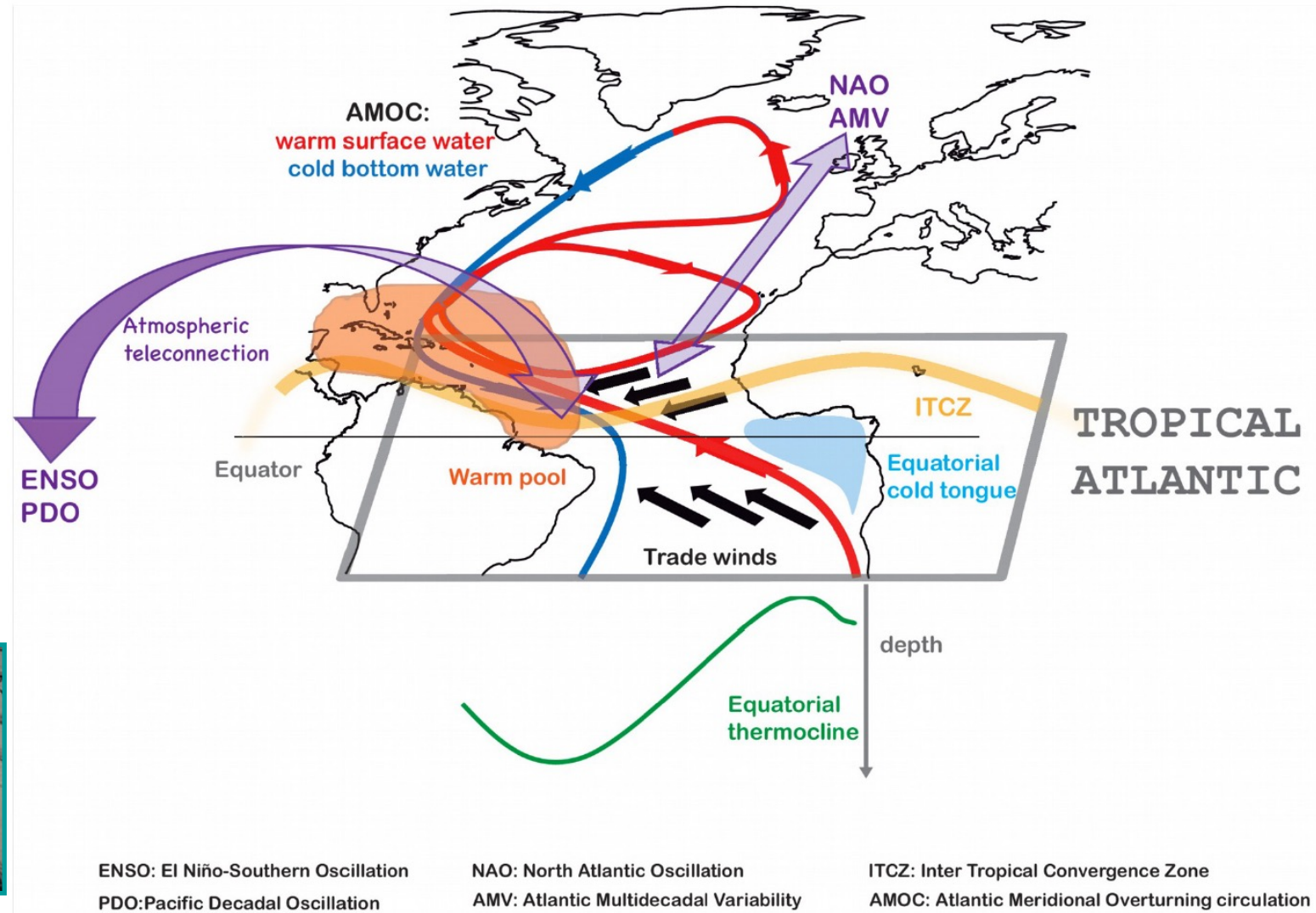




# PIRATA in the Tropical Atlantic : why ?

Science & societal drivers:

- Rainfall
- Tropical cyclones
- Biogeochemistry, carbon, OMZ
- Ecosystems and pollution



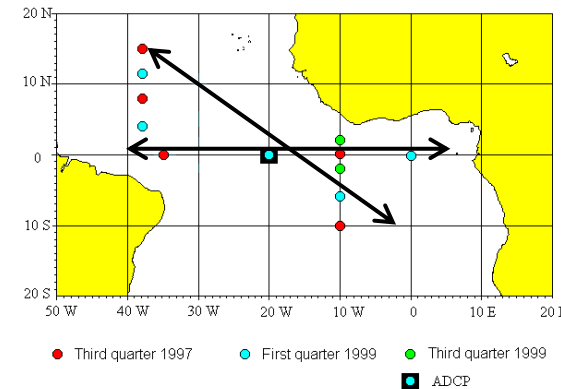
→ Environmental and societal impacts in Northeastern Brazil

Foltz et al., 2019



# PIRATA in the Tropical Atlantic : why ?

- Fundamental scientific issues
- Societal needs for improved prediction of the climatic variability and its impact on the regional hydroclimates



*PIRATA network as drawn initially*

## Main objectives :

- 1-** Improve the description of the intra-seasonal to inter-annual variability in the atmospheric and oceanic boundary layers in the tropical Atlantic
- 2-** Provide a set of data useful for developing and improving the predictive models of the ocean-atmosphere coupled system



# Short/Long term Forecasts:

## Continuous and long term observations are needed

CLIVAR-WCRP (1<sup>st</sup> PIRATA Review)

10 ATLAS buoys



11 T + 4 C  
2 press.  
1 ADCP (2001 ...)

17 ATLAS buoys



+NEE: 4 buoys  
+SWE: 3 buoys  
(6 flux ref. sites)  
+ 2 ADCPs and CMs (Eq.)

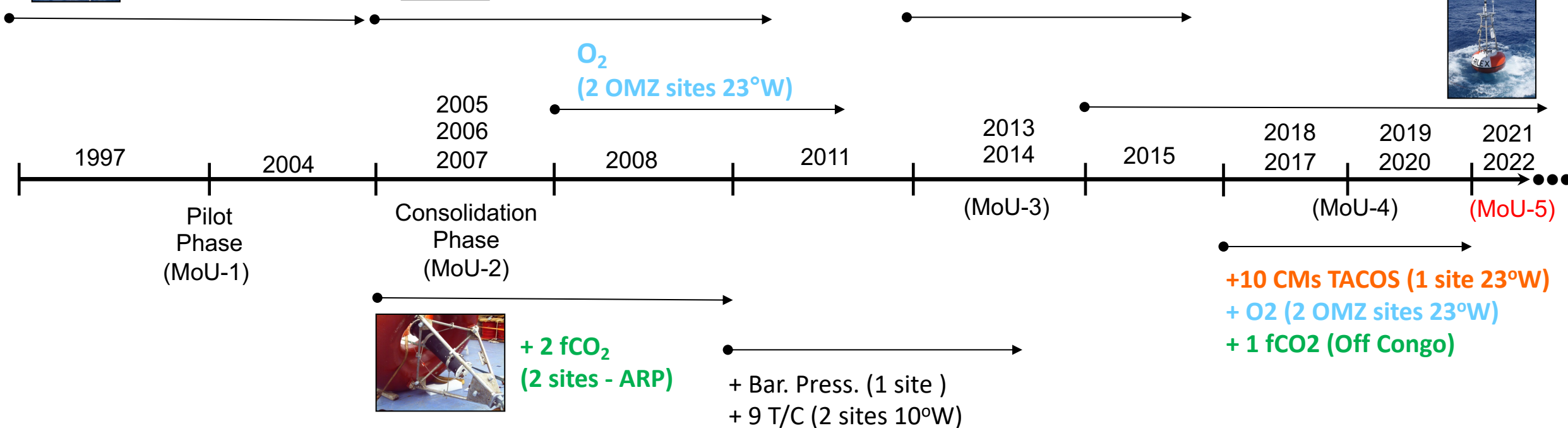
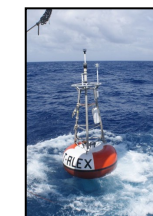
18 ATLAS buoys



+1 buoy (Off Congo)  
+ 18 OTNs (All sites)  
+ 10  $\chi$  pods (2 sites Eq.)

TAOS Review report  
(2<sup>nd</sup> PIRATA Review)

10 T-FLEX + 8 ATLAS







# Short/Long term Forecasts:

Continuous and long term observations are needed

10 ATLAS buoys



11 T + 4 C  
2 press.  
1 ADCP (2001 ...)

CLIP

## PIRATA ATLAS buoys:

### Measured Parameters :

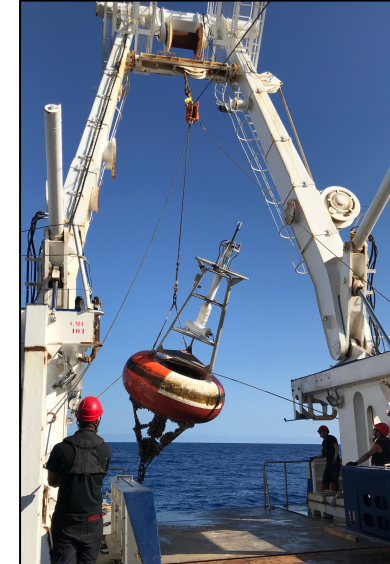
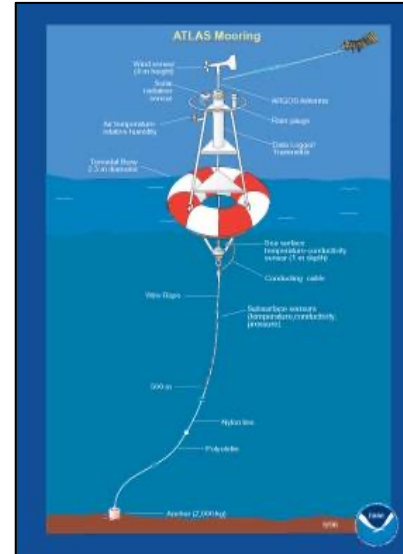
#### Atmosphere:

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

#### Ocean:

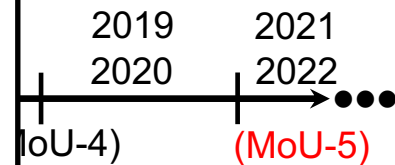
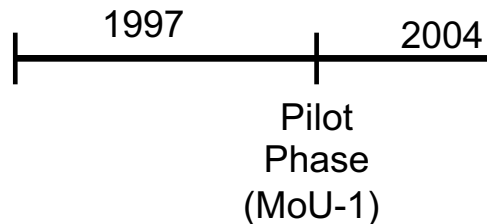
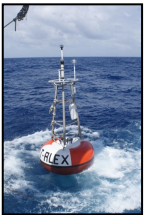
- temperature (11 levels from surface to 500m)
- salinity (4 to 9 levels between 0 & 120m)
- pressure (at 300 & 500m)
- surface currents at several sites

- Daily averaged data transmitted in real time by Argos;
- High frequency data (10mn) available after servicing operations



S Review underway  
2nd PIRATA Review)

1 T-FLEX + 7 ATLAS



TACOS (1 site 23°W)  
MZ sites 23°W)  
Off Congo)



# Improving PIRATA network

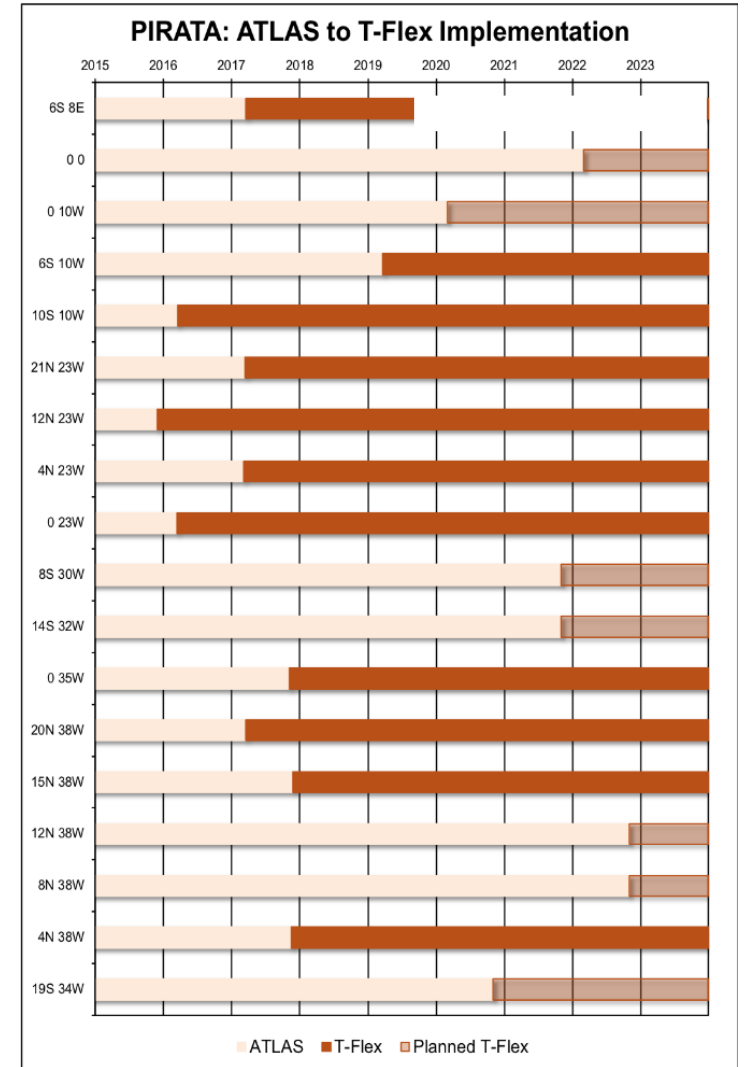
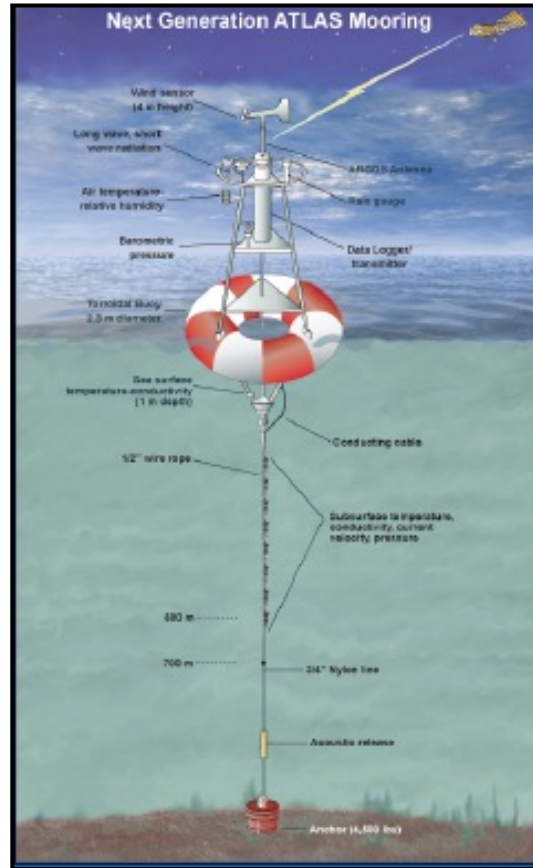
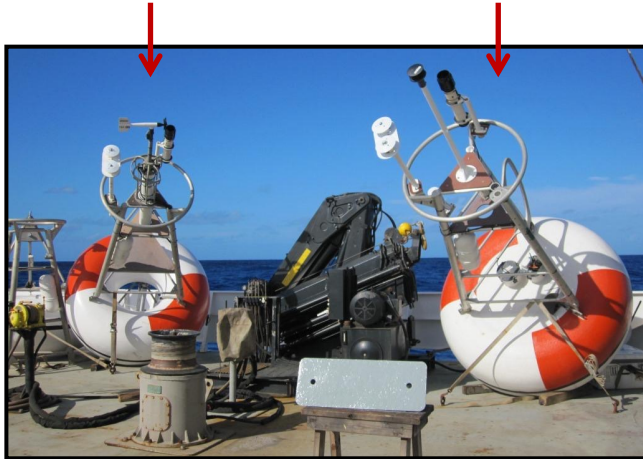
*T-FLEX implementation was underway ...*

From 2015 : 10 T-FLEX buoys

*... suspended in 2020*

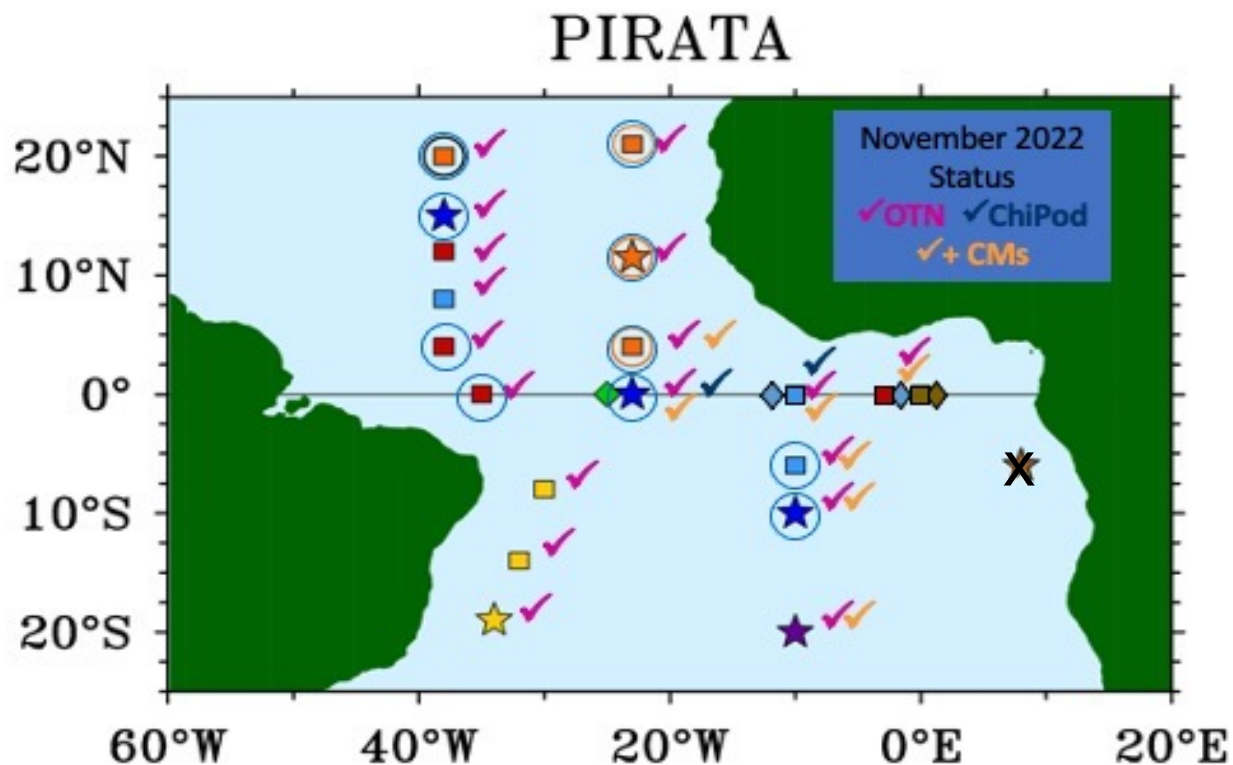
ATLAS

T-FLEX





# Prediction and Research moored Array in the Tropical Atlantic – PIRATA network



- Standard ATLAS
- ◆ ADCP
- ★ ★ ★ ★ Flux Reference Site
- Northeast Extension
- Southwest Extension
- ★ Pilot Deployment
- Meteo France BP
- CO<sub>2</sub>/O<sub>2</sub> Enhanced ATLAS
- O<sub>2</sub> Enhanced ATLAS
- New T-Flex systems
- ◆ Additional ADCP
- ★ Southeast Extension (Suspended)
- ◆ Temporarily Suspended
- Temporarily Suspended

18 meteo-oceanic buoys : ATLAS & T-Flex atmospheric parameters + EOVS (T, S, currents ...)

- OTN (acoustic sensors) at 200 m
- Xpods (turbulence) at 23W-0N & 10W-0N
- 2 surface CO<sub>2</sub> sensors at 10W-6S & 10W-0E\*
- 2 O<sub>2</sub> subsurface sensors at 23W-4N & 23W-11.5N  
 + 1 O<sub>2</sub> subsurface sensor will be deployed at 10W-0N in 2023

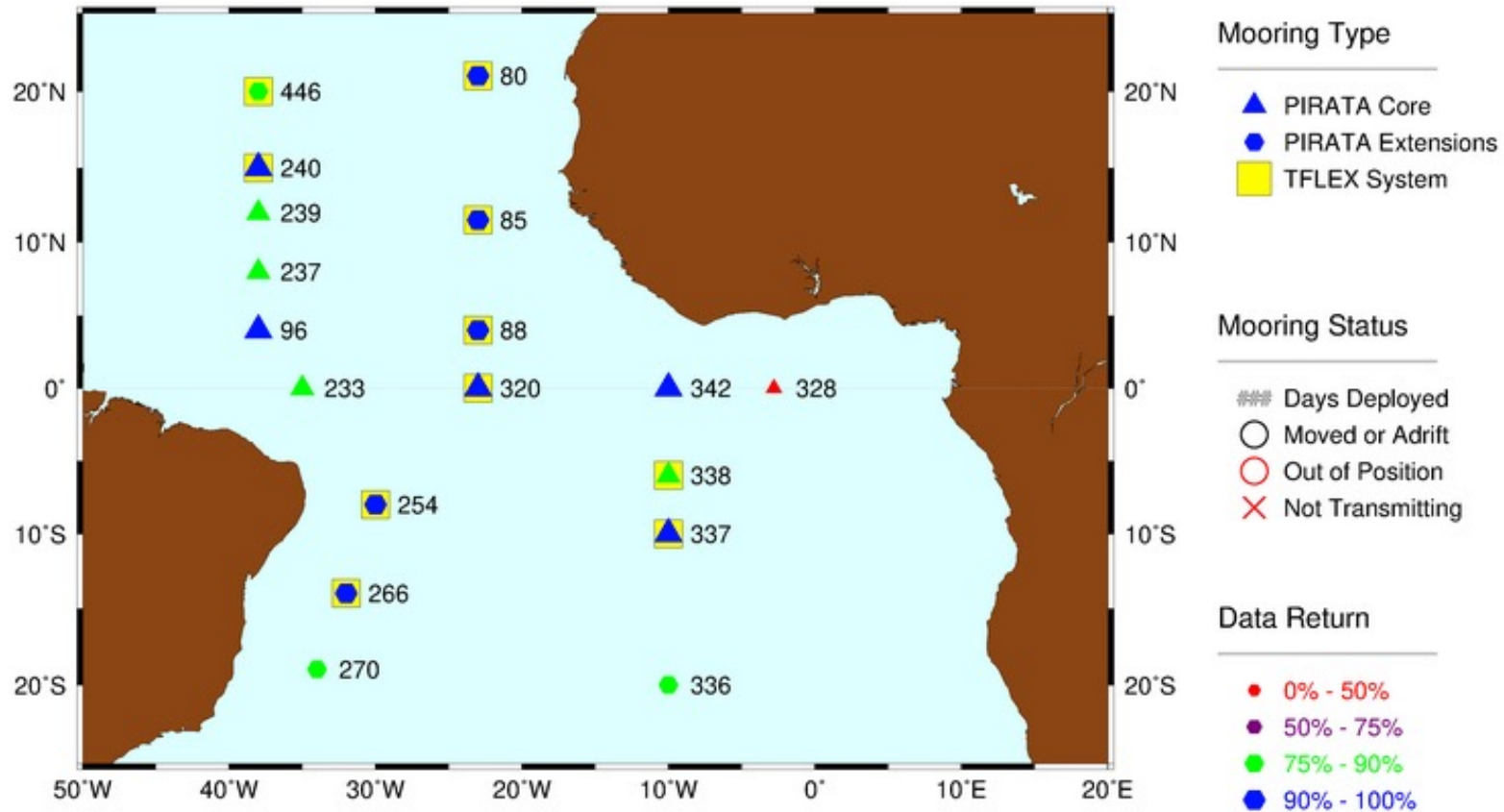
+ 3 ADCP moorings (0-300 m) along the equator at 23W, 10W & 0E

# Prediction and Research moored Array in the Tropical Atlantic – PIRATA network



## Status of Presently Deployed PIRATA Moorings

Updated Feb 13, 2023







# Prediction and Research moored Array in the Tropical Atlantic – PIRATA – Servicing Cruises

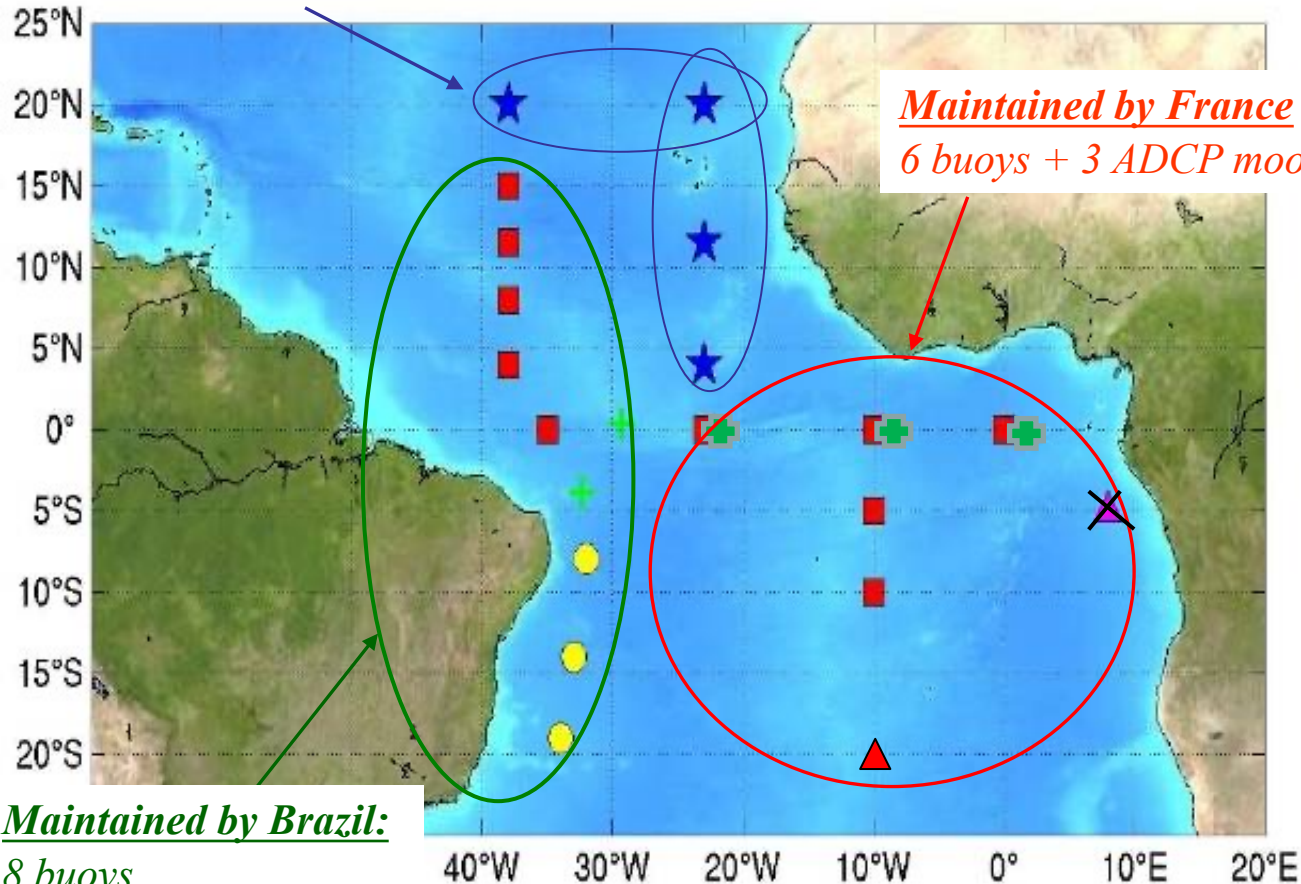
## Typical sea work year:

T-FLEX/ATLAS moorings deployed: 18

Shiptime: ~ 120 days

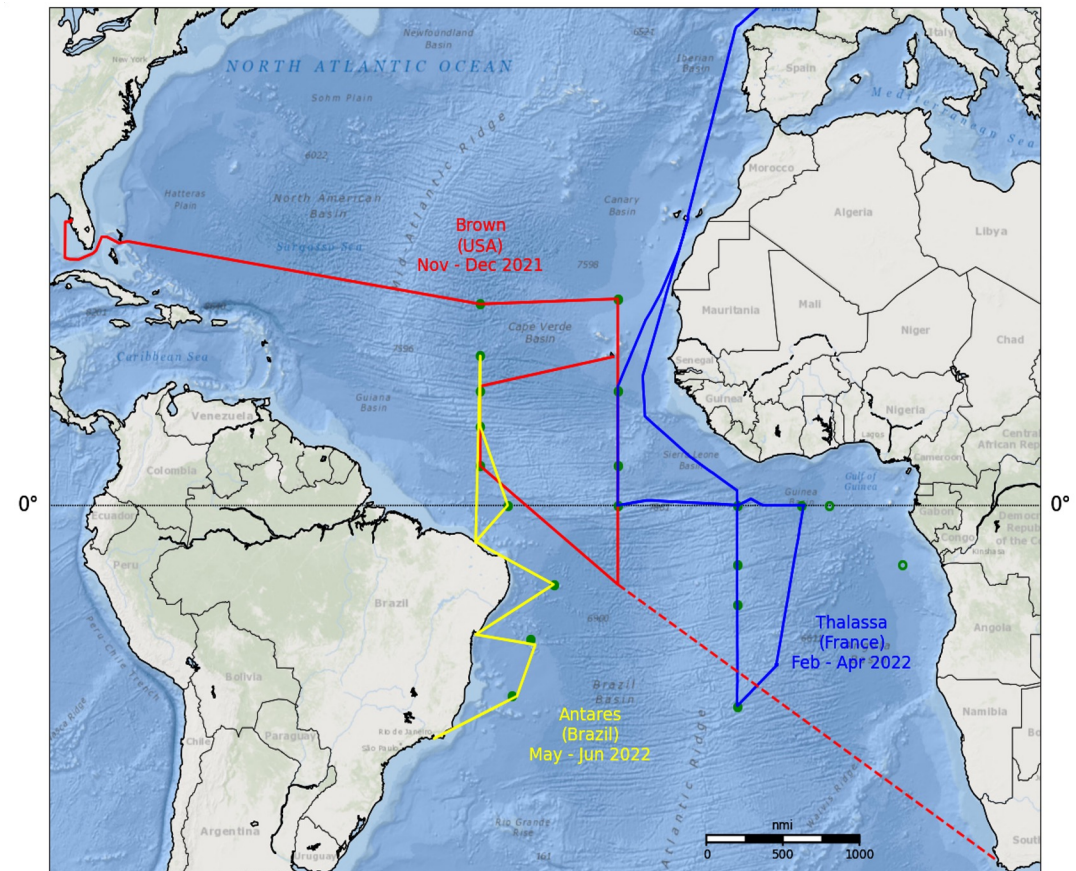
### Maintained by USA:

4 buoys + sensors calibration



*Maintained by France*  
6 buoys + 3 ADCP moorings

## PIRATA Cruises Oct 2021 – Sep 2022



Yearly cruises → repeated sections with CTD profiles at 38°W (BR), 23°W (US), 10°W (FR)

### Maintained by Brazil:

8 buoys

# From 2003 : deployment of ARGO profilers in the eastern tropical Atlantic

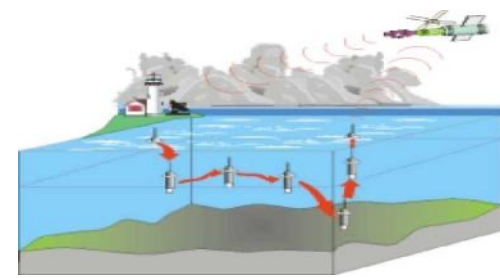
**Contribution to TGIR ARGO, through CORIOLIS**

About 6-8 deployments during yearly French cruise :

**163** profilers deployed from 2003



Data in poorly documented regions (southeast)



**Vertical resolution:**

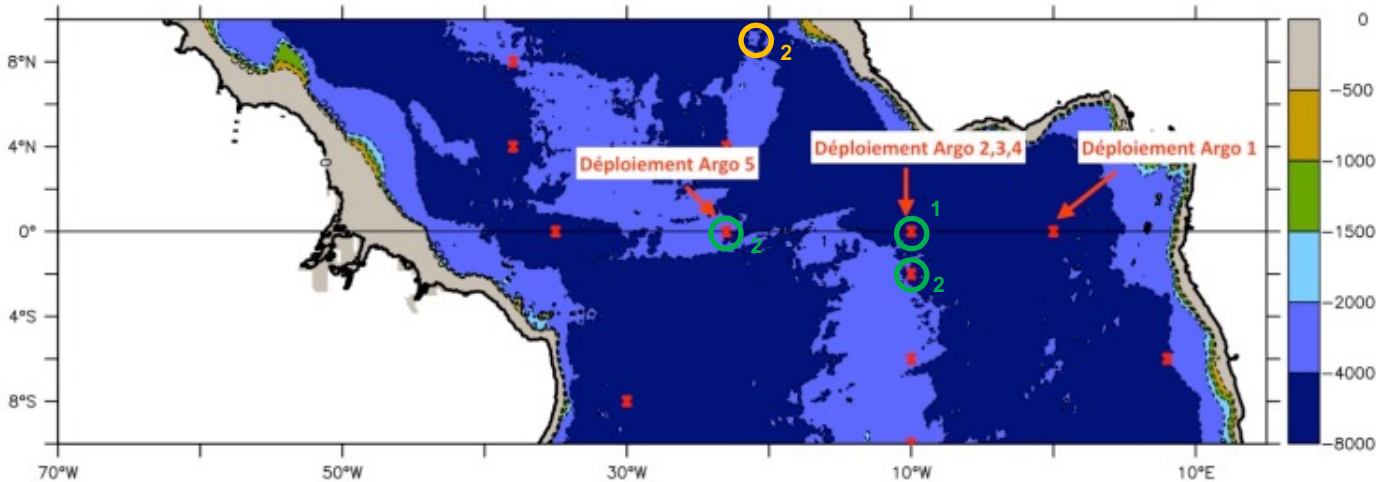
0-100m = 1m

100-200m = 5m

200-2000m = 25m

**PIRATA-FR31**

**12 deployments**



Courtesy: N. Poffa

**5 ARVOR T/S profilers (LEFE-GMMC PODIOM)**

**5 BGC-ARGO profilers (H2020 Eurosea WP7)**

**2 BGC-ARGO profilers (LEFE-GMMC SENOX)**

=> need of T/C measurements for ARGO profiles validation down to 2000 m (or 4000 m for Deep-ARGO) + HPLC & DIC/TA measurements for BGC-ARGO.

=> All CTD-O<sub>2</sub> profiles are down to 2000m depth during all PIRATA-FR cruises.





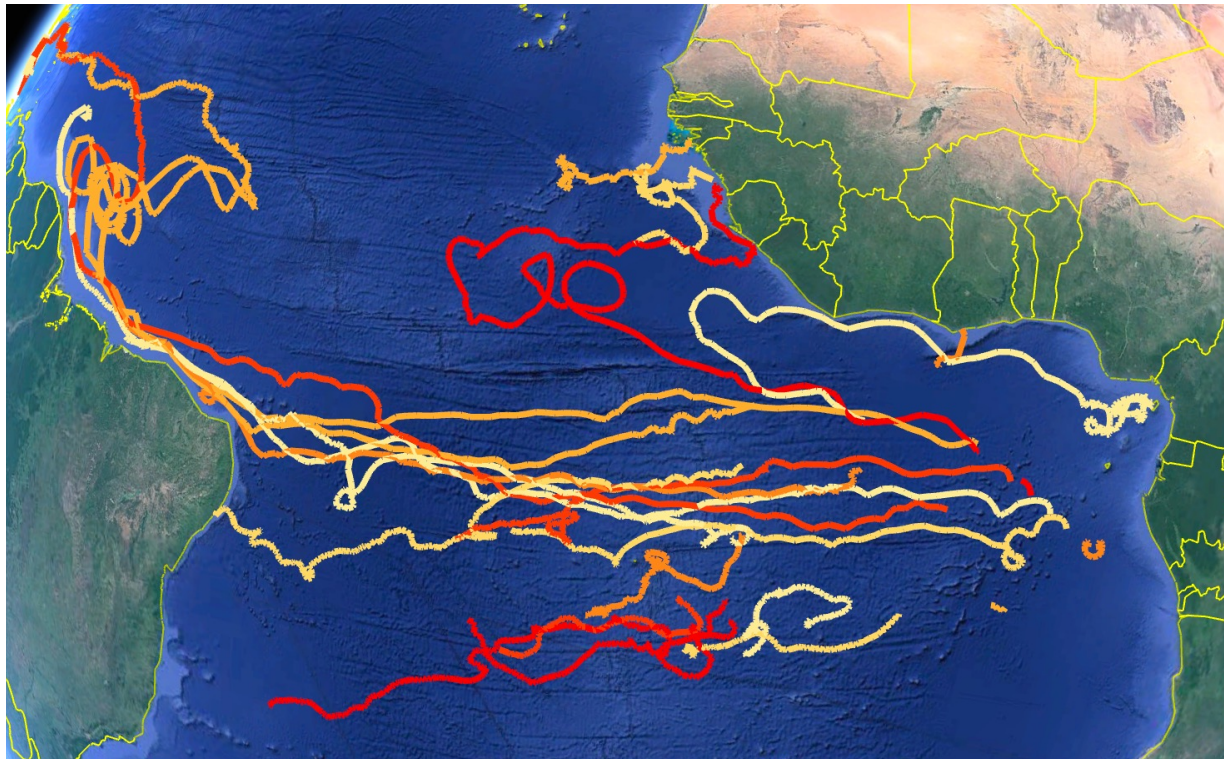
# From 2005 : deployment of surface drifters in the eastern Tropical Atlantic

(SVP, SVP-B, SVP-BS)

## Contribution to Global Drifter Program (GDP/DBCP)

From 5 to 25 deployments during yearly French cruise :  
**189** drifters deployed from 2005

Through Meteo-France, NOAA/AOML & contribution to AtlantOS



### Drifters deployed (Meteo-France) :

**PIRATA-FR31 : 23 drifters**

**PIRATA-FR32 : 8 drifters**

**PIRATA-FR33 : 10 drifters to be deployed**

*Example:*

*Trajectories of the SVP deployed during  
PIRATA-FR cruises between 2016 to 2018  
as contribution to AtlantOS & NOAA GDP  
(M. Le Garrec, pers. comm.)*

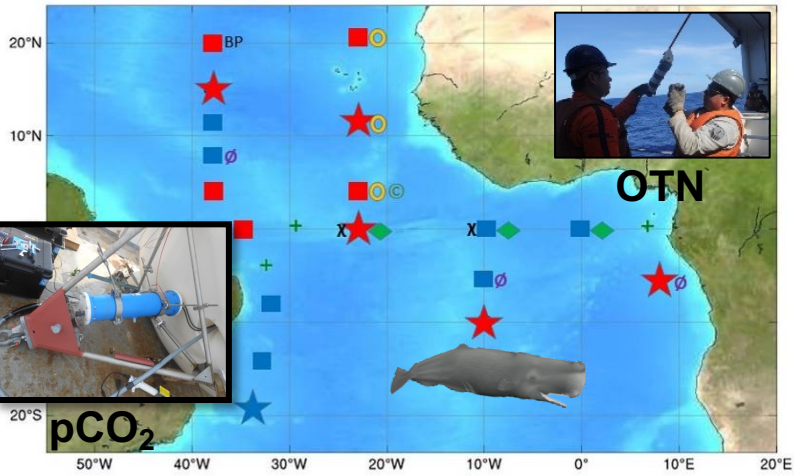




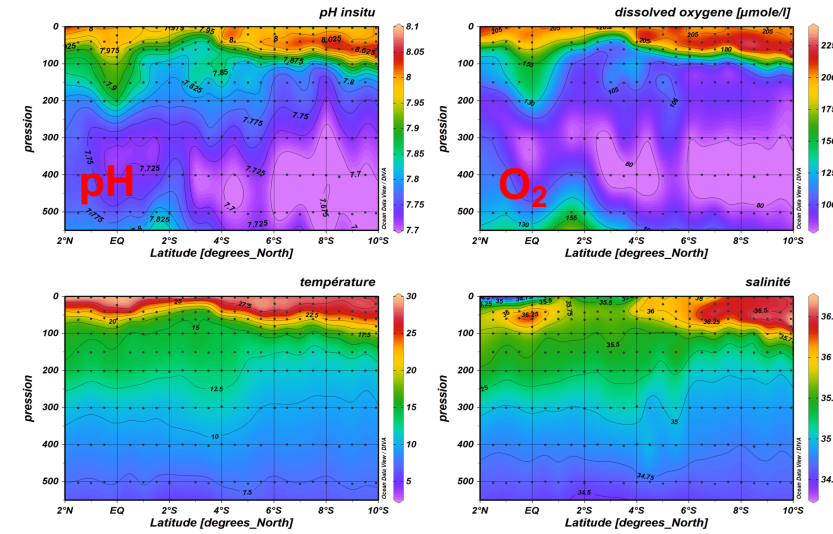
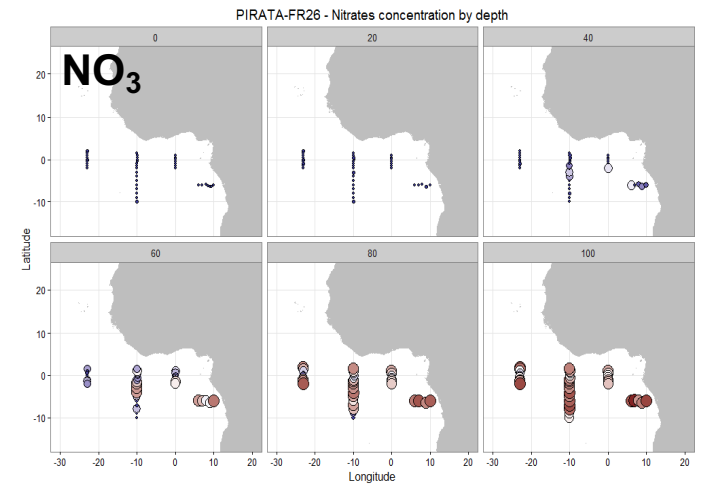
# Prediction and Research moored Array in the Tropical Atlantic - PIRATA

**EOVs integration: by integrating physical-biogeochemical-biological measurements**

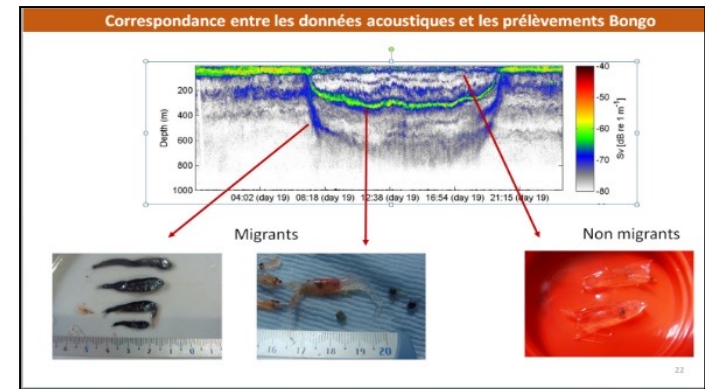
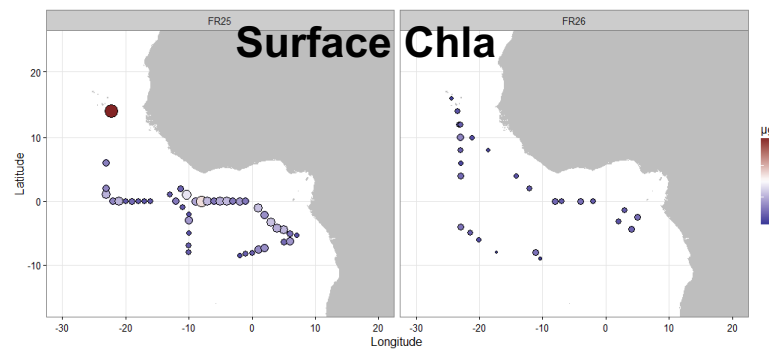
CTDO<sub>2</sub>/LADCP, Nutrients, pCO<sub>2</sub> (underway and fixed moorings), O<sub>2</sub> (OMZ), **pH**, **TA**, Chlorophyll pigments, POM, C13 & O18, Acoustics, Mammals (OTN), Tuna Hg contamination



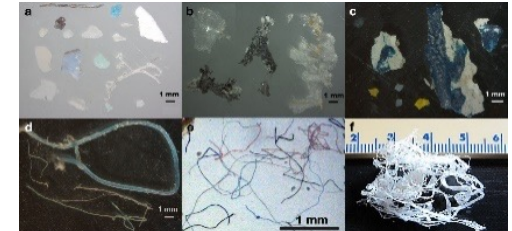
⊖ : CO<sub>2</sub> sensor   ⊙ : O<sub>2</sub> sensor   ⊗ : Currentmeters   X : Turbulence sensors  
BP : Barometric pressure sensor



Link with **Acoustic data**  
(and T/S/O2/ADCP/nutrients/Chl pigments...)



Microplastics





# Conclusions and prospective



⇒ **PIRATA is a platform for several additional measurements**

⇒ **PIRATA servicing cruises offer repeat section sampling and additional experiments**

- Contribution to other international programs: ARGO, DBCP, OTN...
- Contribution for possible process studies (turbulence sensors, gliders...)
- Sea water samplings for BioGeoChemistry ( $O_2$ ,  $CO_2$ , pH, Total Alkalinity, nutrients, pigments...)
- **Real-time data (now hourly) assimilated in operational systems**
- **Impact studies not adequately define to measure PIRATA's added value**

⇒ **IN THE FUTURE: TAOS recommendations for PIRATA (Foltz et al, 2019):**

- **Sustain the existing network** to carry on long term time series
- **Increase T/S sensors in the mixed layer**, add **surface currents** and **fluxes** measurements
- Add Barometric Pressure sensors at different sites (Hervé Giordani)
- Expand **biogeochemical measurements at every site**
- Extend PIRATA array (new moorings) in the **South Atlantic**, and in the **North Atlantic warm pool**



## 26th Prediction and Research Moored Array in the Tropical Atlantic Meeting

The PIRATA-26 meeting will be held in Banyuls-sur-mer, France from 16 to 20 October 2023.

*Colloquium on Tropical Atlantic Research on present and future accomplishments welcoming exchanges on:*

Ocean dynamics and air-sea interactions, Tropical Atlantic climate variability and long term changes, Extremes events, Biogeochemistry, pollution and marine ecosystems, Data assimilation, weather and climate forecasts

