Institut de Recherche pour le Développement
FRANCE

Environmental forcing of marine organisms as revealed by underwater acoustics in the eastern tropical-equatorial Atlantic

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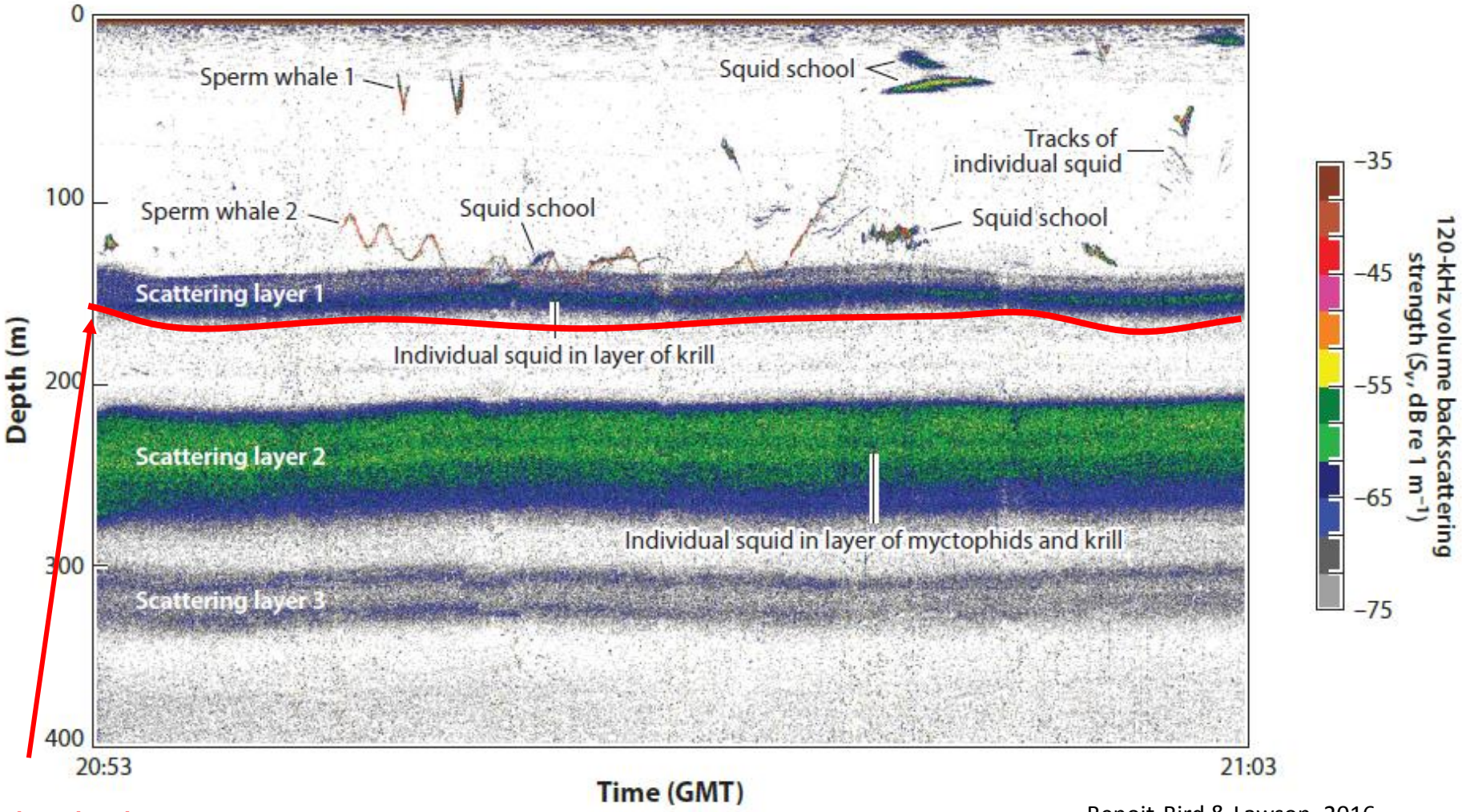
LEGOS

LEMAR

marbec
marine biodiversity exploitation & conservation

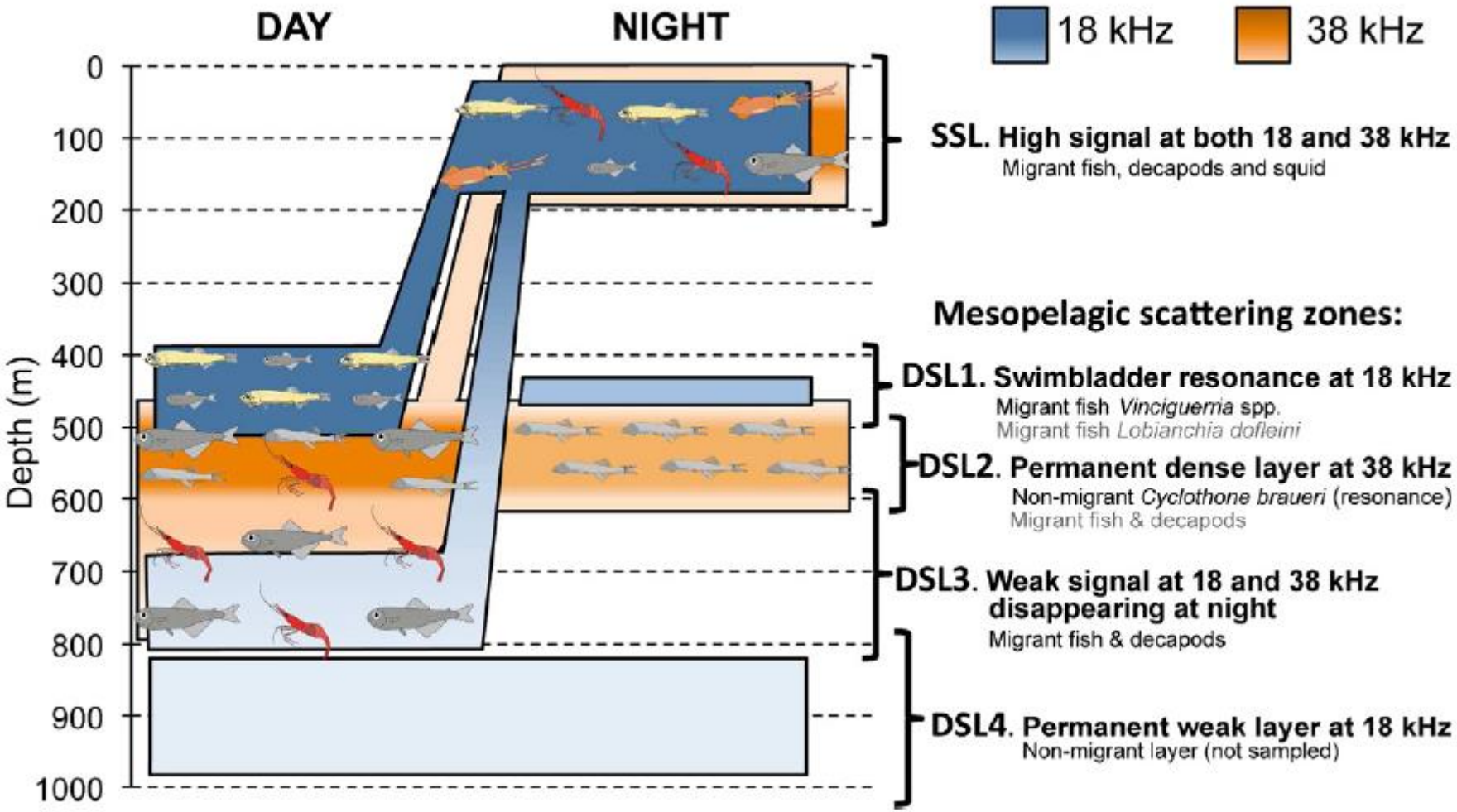
INTRODUCTION



Benoit-Bird & Lawson, 2016

Physical structures
(Ex. thermocline, internal waves, etc., e.g. Grados et al. 2016 PinO)

Biological carbon pump

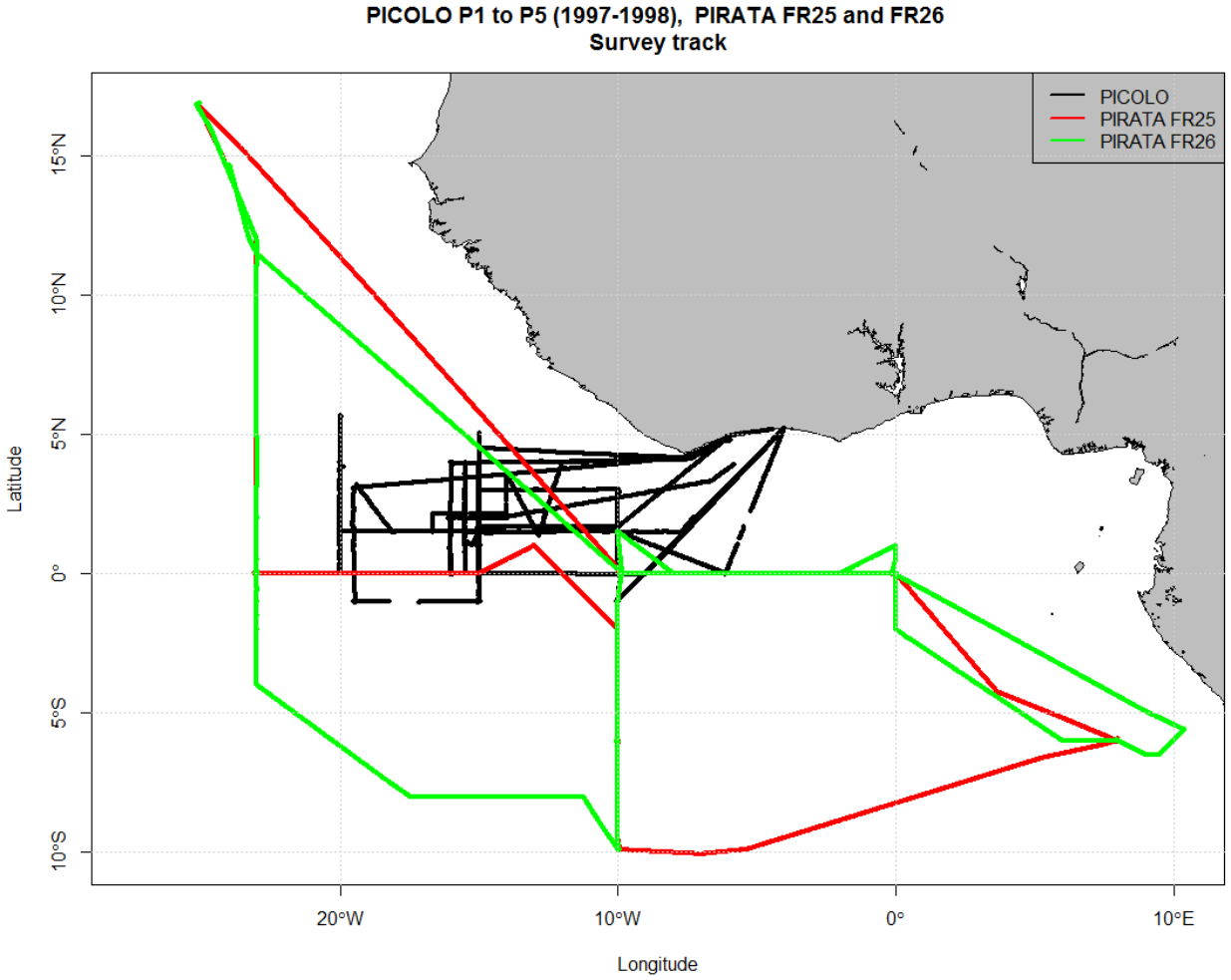


Ariza el al. 2016

Need to describe this substantial active flux

INTRODUCTION

Few acoustics data since PICOLO cruises (1997-1998)



Since 2015, data collected during French PIRATA cruises

➔ **Strong potential !**

- Use PIRATA acoustic data to infer the distribution of mesopelagic organisms (zooplankton and fish)

- How ocean features can impact the **patterns** of **horizontal** distribution of fish and zooplankton distribution ?

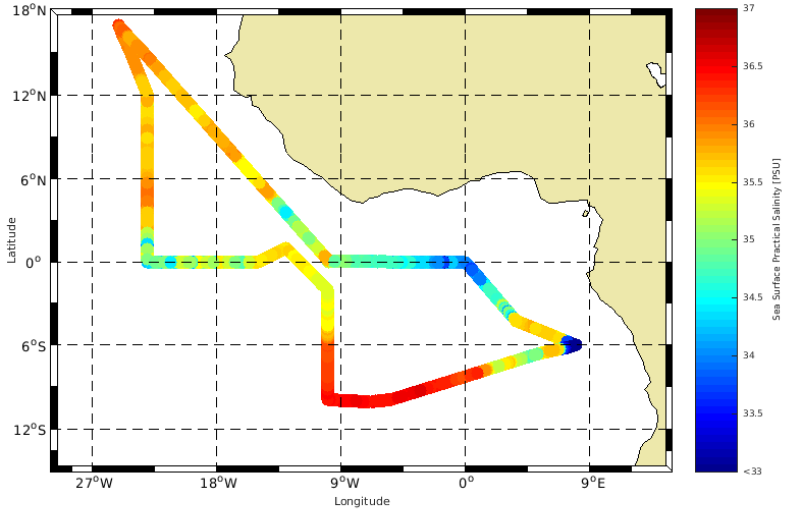
- How the vertical structure (including thermocline, oxycline and peak of fluorescence) drives (or not) the **vertical patterns** of organisms distribution ?

DATA

1 **Characterization of water masses**

- Thermosalinograph
- CTD-O2
- Nutrients
- Pigments
- S-ADCP

SSS – PIRATA FR25

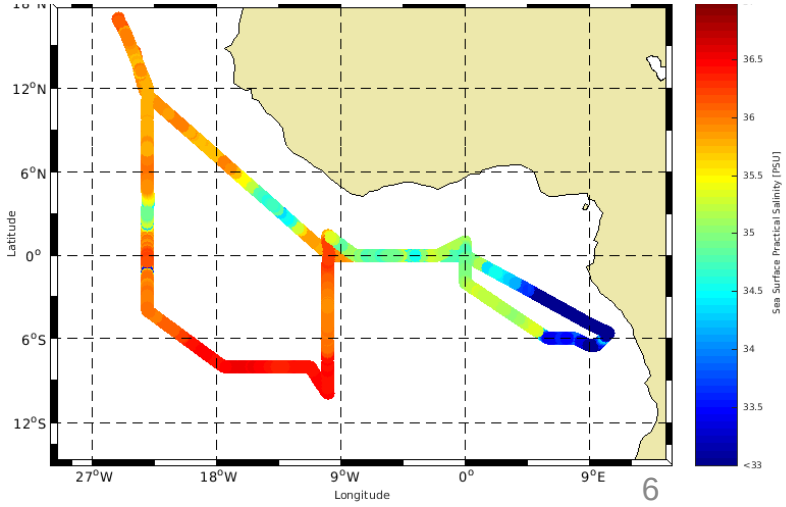


2 **Ecosystem acoustics**

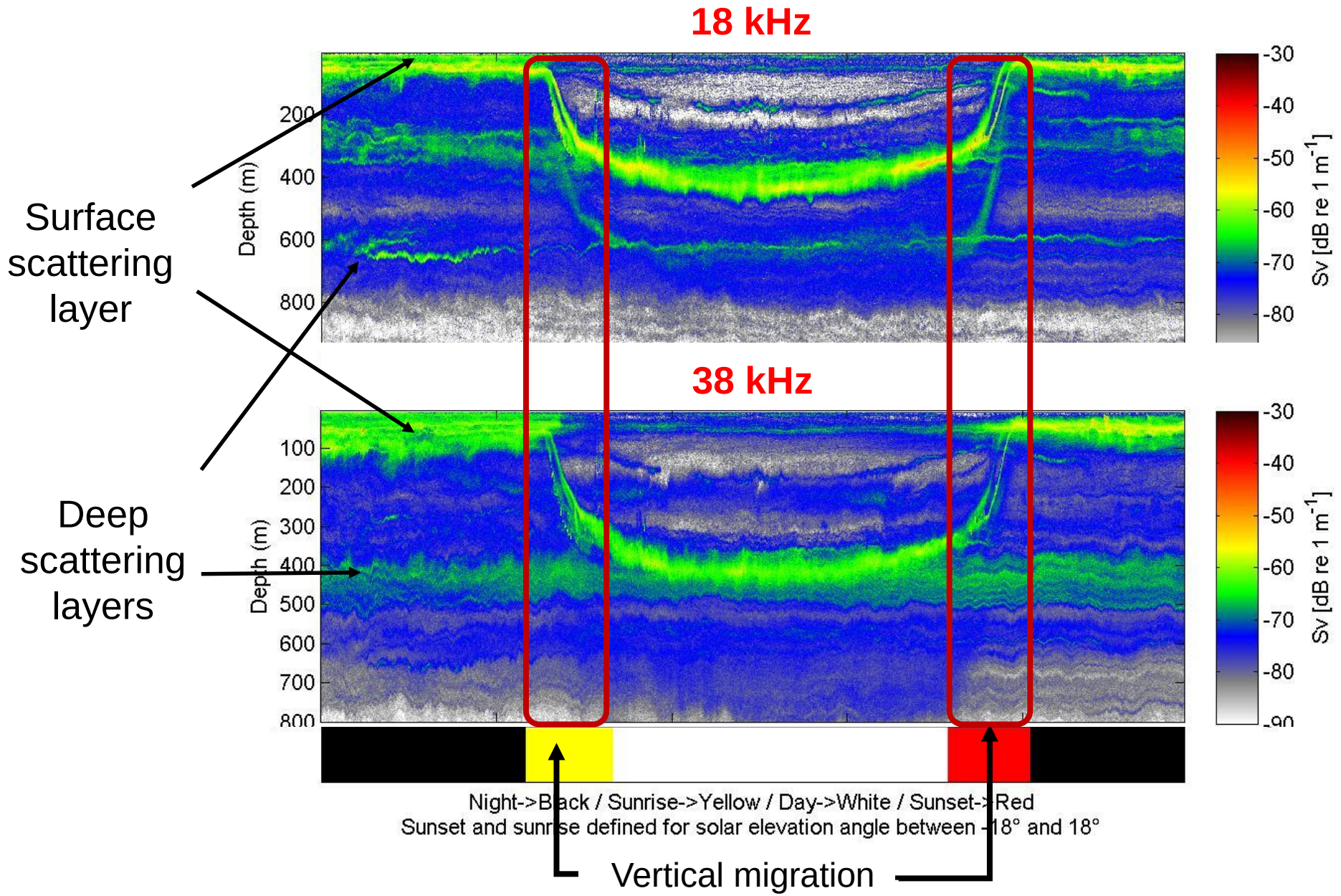
18, 38, 70, 120, 200, 333 kHz

Down to a maximum depth of 1000 m for 18 and 38 kHz

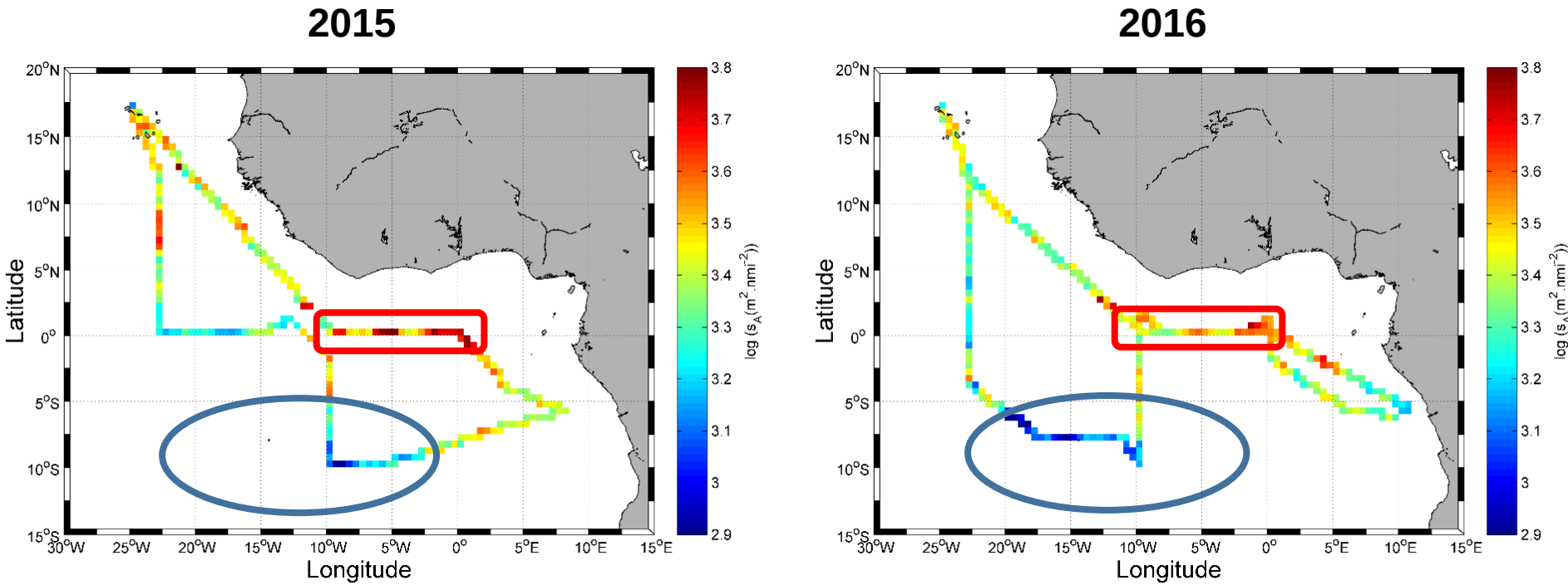
SSS – PIRATA FR26



Example of a 24h registration



Mean acoustic biomass of the whole water column at 38kHz

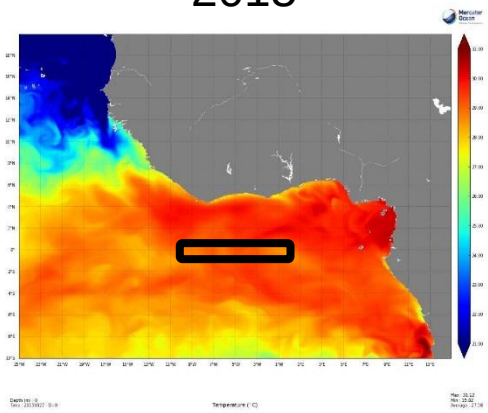


- Higher acoustic biomass in the eastern part of equatorial band
- Lowest value in the south/southwest part of the study area: oligotrophic waters with low CHL-a surface concentration

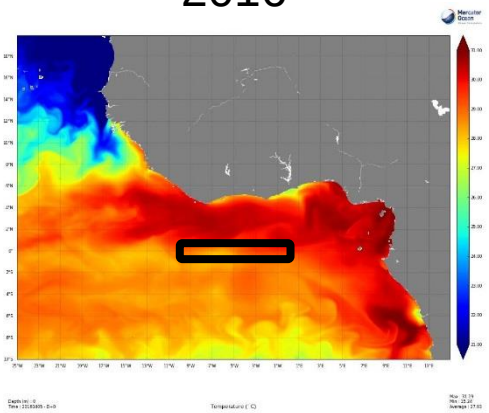
Equatorial upwelling impact

SST

2015

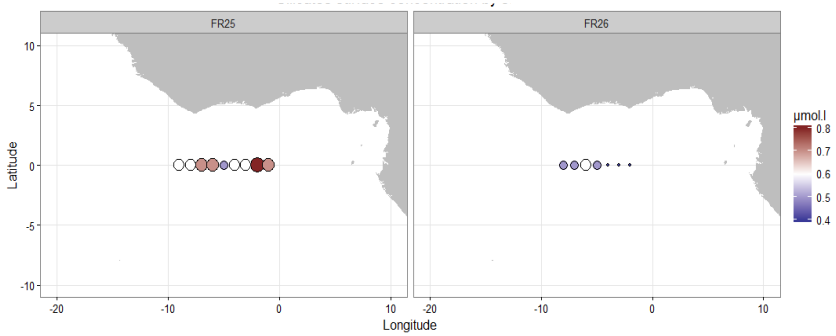


2016

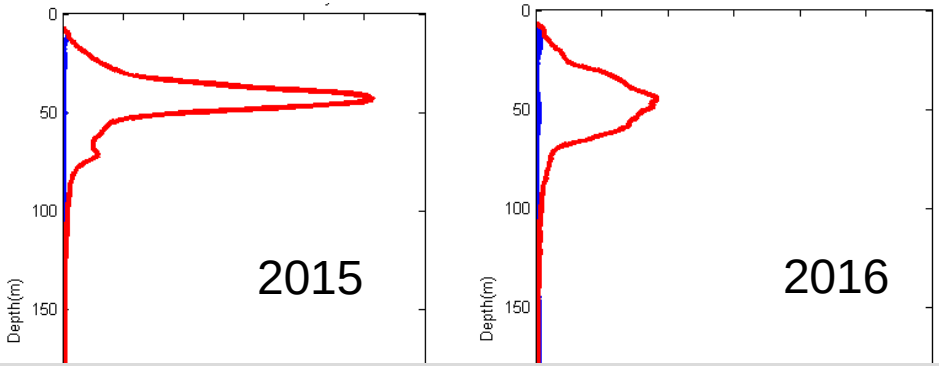


Silicates surface concentration

2015 2016

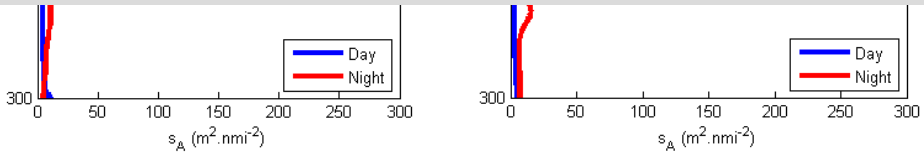


Mean acoustic biomass profile at 18 kHz



Colder SST in 2015

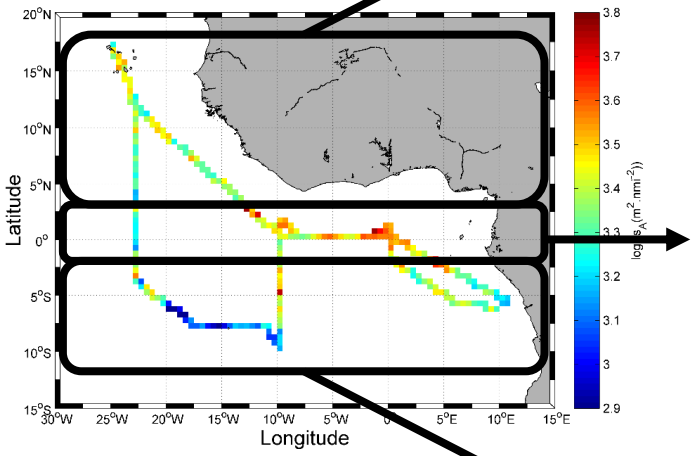
➔ More nutrients ➔ Higher acoustic biomass



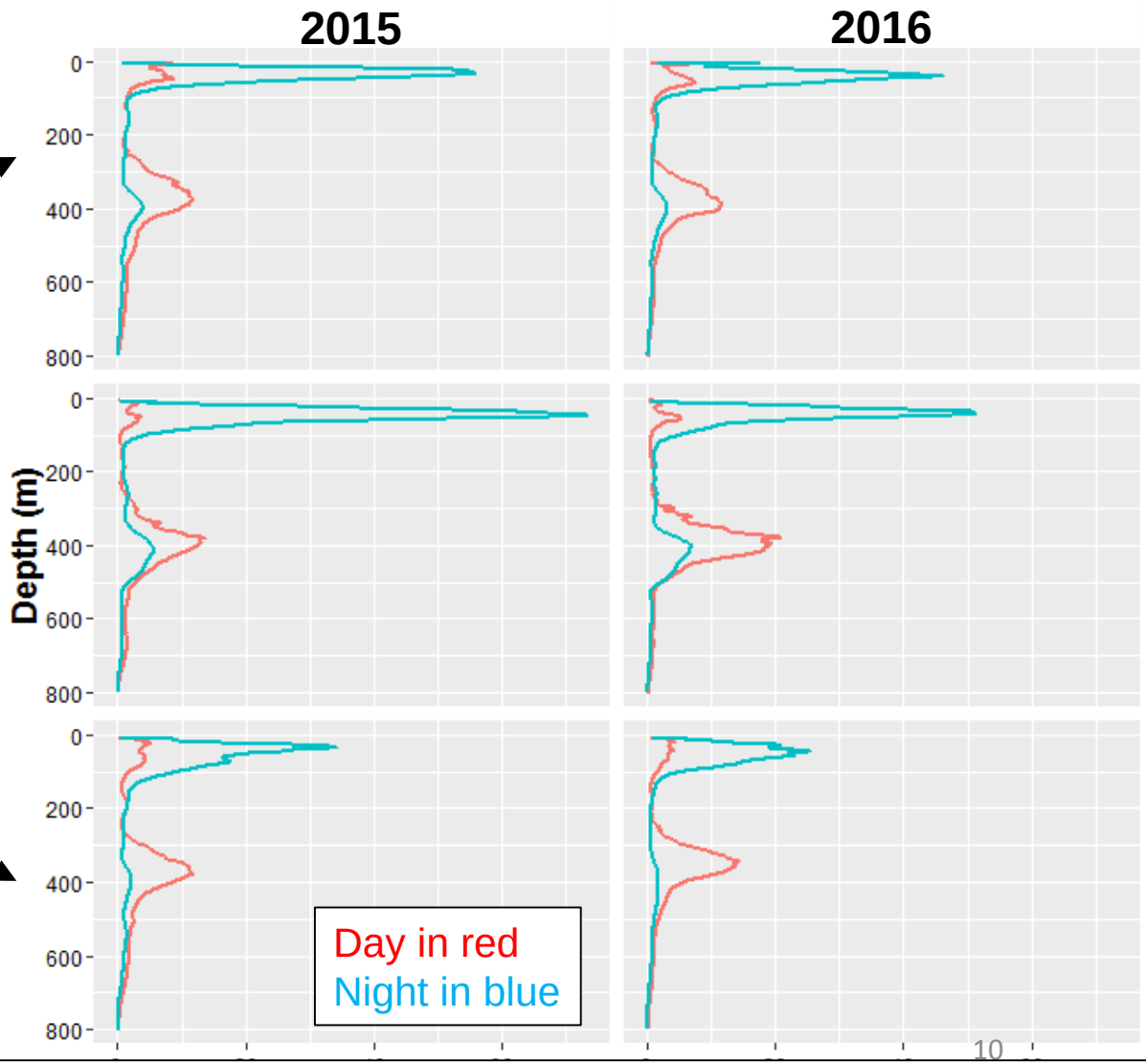
RESULTS

Vertical distribution patterns

Example of 2016



Mean acoustic biomass profile at 38 kHz

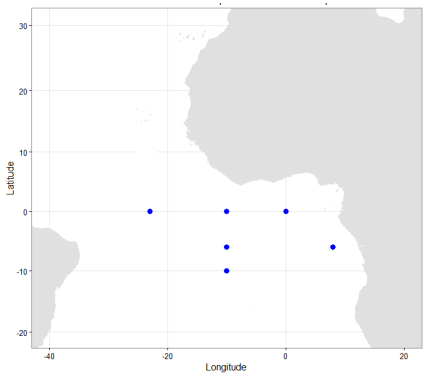


Surface acoustic biomass

North tropical Atlantic and the equatorial band > South tropical Atlantic

RESULTS

Vertical distribution patterns



Mean acoustic biomass profile comparison between the 6 PIRATA buoys

10W 0N | 10W 6S | 10W 10S | 23W 0N | 0W 0N | 8E 6S

FR25

FR26

Depth (m)

0 200 400 600 800

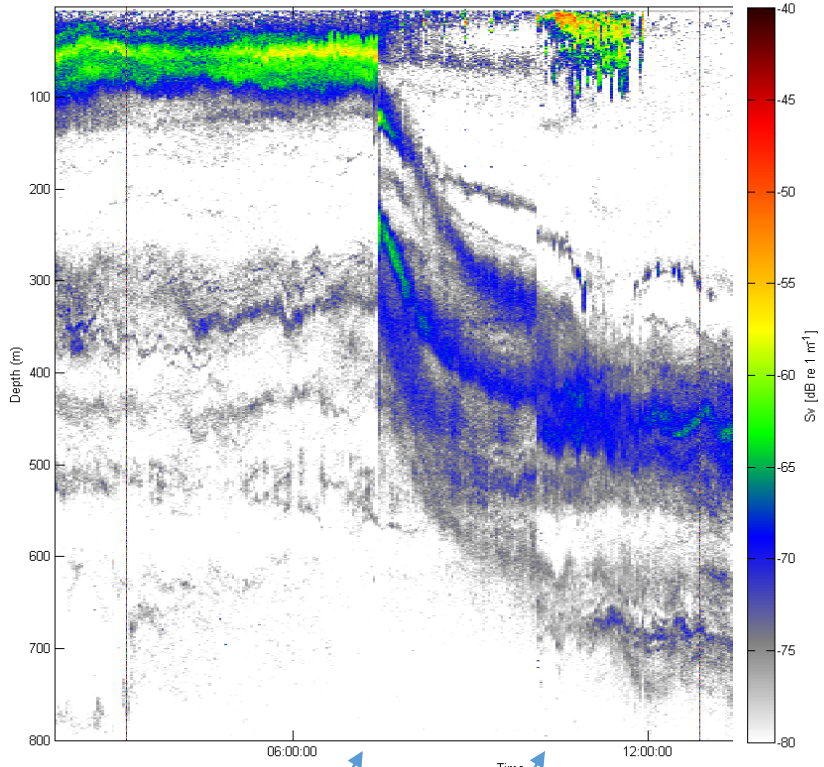
Strong interannual and spatial variability

RESULTS

Vertical distribution and hydrology

10°S-10°W : ~15h registration (4H-20H) & operations

Echogram at 18 kHz



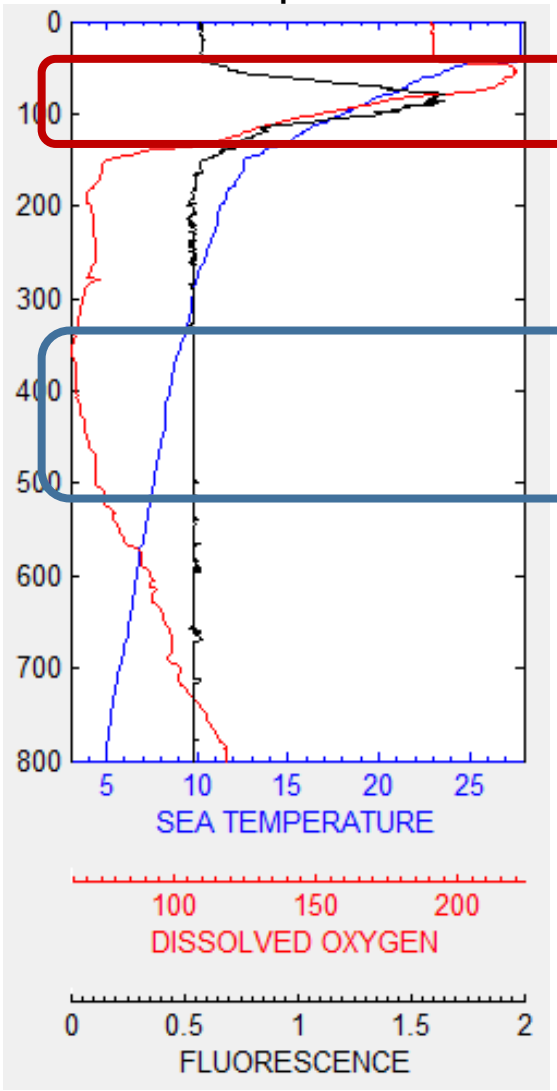
CTD

Buoy

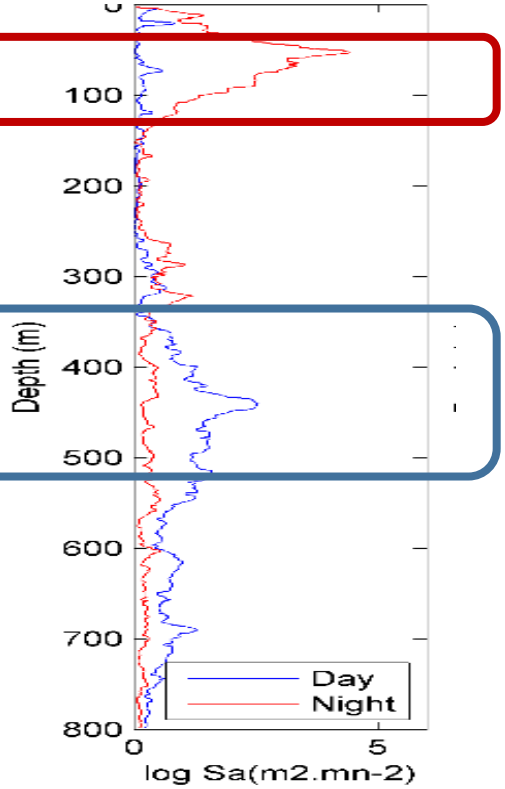
Acoustic profile night

Acoustic profile day

CTD profile



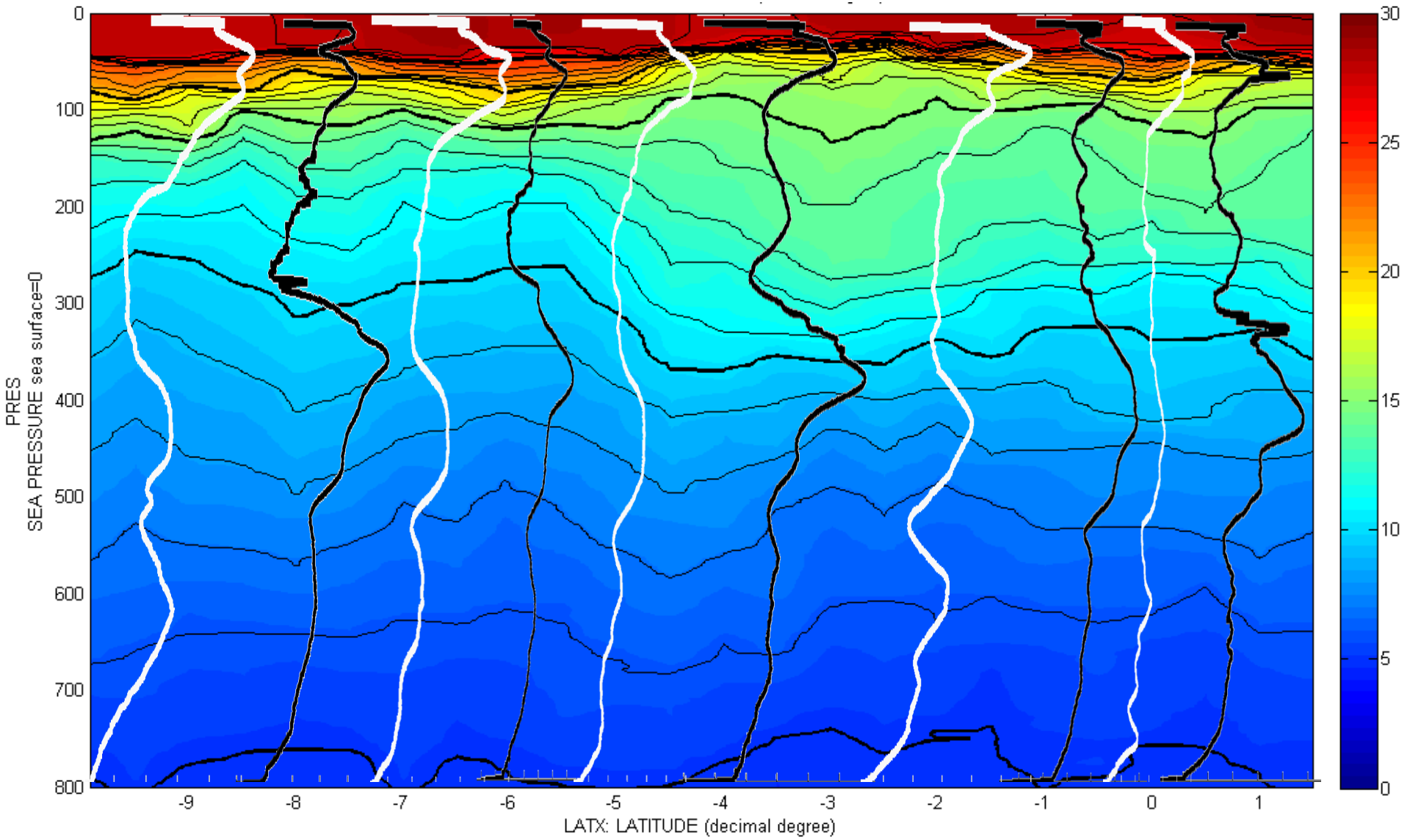
18kHz



Acoustic profile

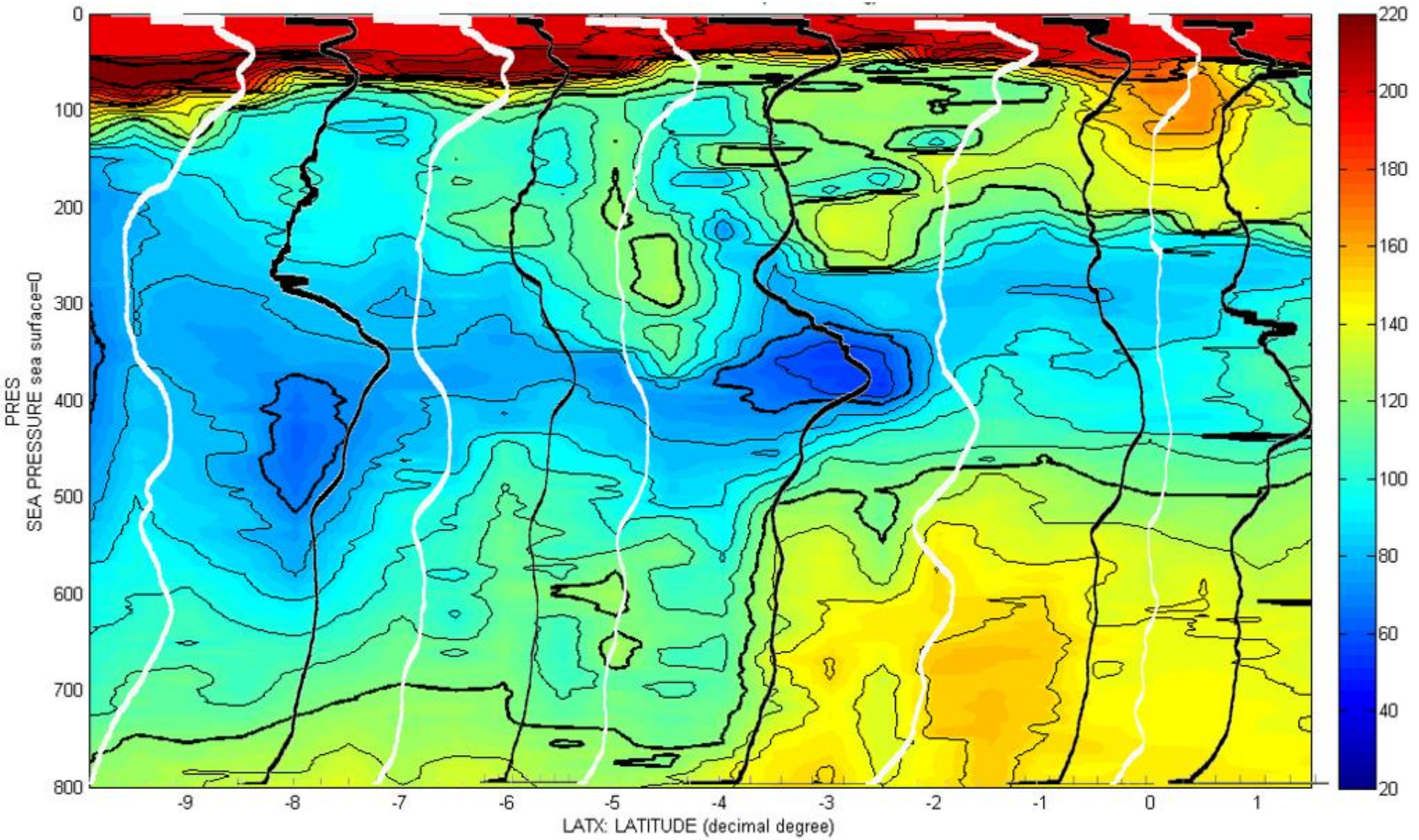
During day, low oxygen zone seems to serve as refuge area

10°W section - Temperature vs daily acoustic profiles at 38 kHz



Day in black, night in white

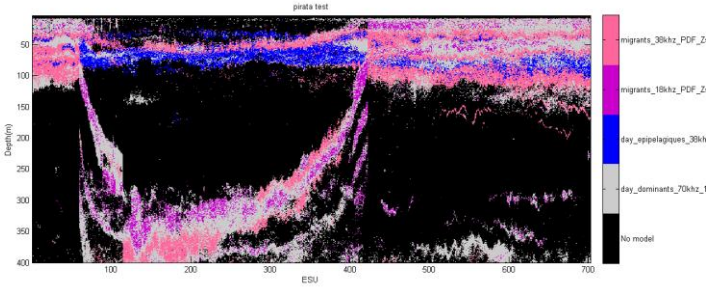
10°W section - Dissolved oxygen vs daily acoustic profiles at 38 kHz



Day in black, night in white

Short term perspectives

- PIRATA FR27 & FR28 processing and interannual comparison
- Better understanding of the biological carbon pump
- Organisms classification using multifrequency method



- PIRATA: opportunity to combine marine communities observations to physics and chemical measurements
- **Please (if possible) do collect acoustic data during US and Brazilian PIRATA cruises !**

Obrigado !

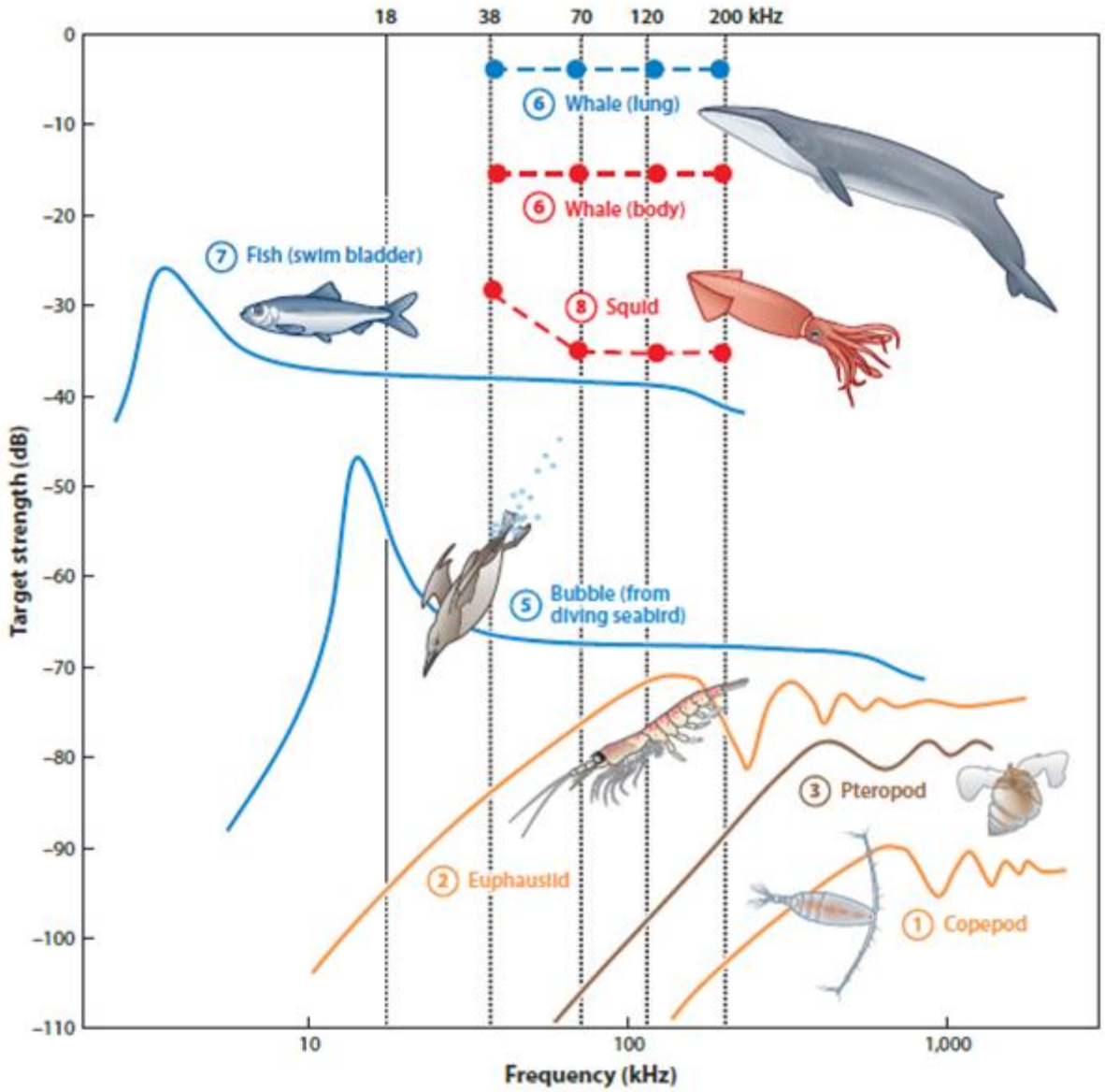
This work was also supported by the EU AtlantOS, PIRATA and PREFACE projects

PREFACE

PIRATA

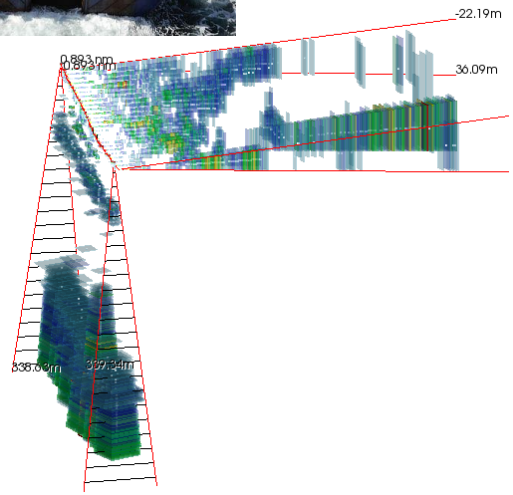
AtlantOS
Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems

EXTRA SLIDES


18
38
70
120
200 kHz
0
−10
−20
−30
−40
−50
−60
−70
−80
−90
−100
−110
Target strength (dB)
6 Whale (lung)
6 Whale (body)
7 Fish (swim bladder)
8 Squid
5 Bubble (from diving seabird)
3 Pteropod
2 Euphausiid
1 Copepod
10
100
1,000
Frequency (kHz)

Acoustic data collection and processing

R/V THALASSA



Sounder : **Simrad EK60**

Vertical

Frequency (kHz)	Range (meters)
18	1000
38	800
70	400
120	250
200	120
333	80

Lateral (FR26 only)

Frequency (kHz)	Range (meters)
120	250

1 ping each 3 seconds = 20 meters
Sampling resolution : 20 cm
Sampling starts at 6 meters depth

Data processing

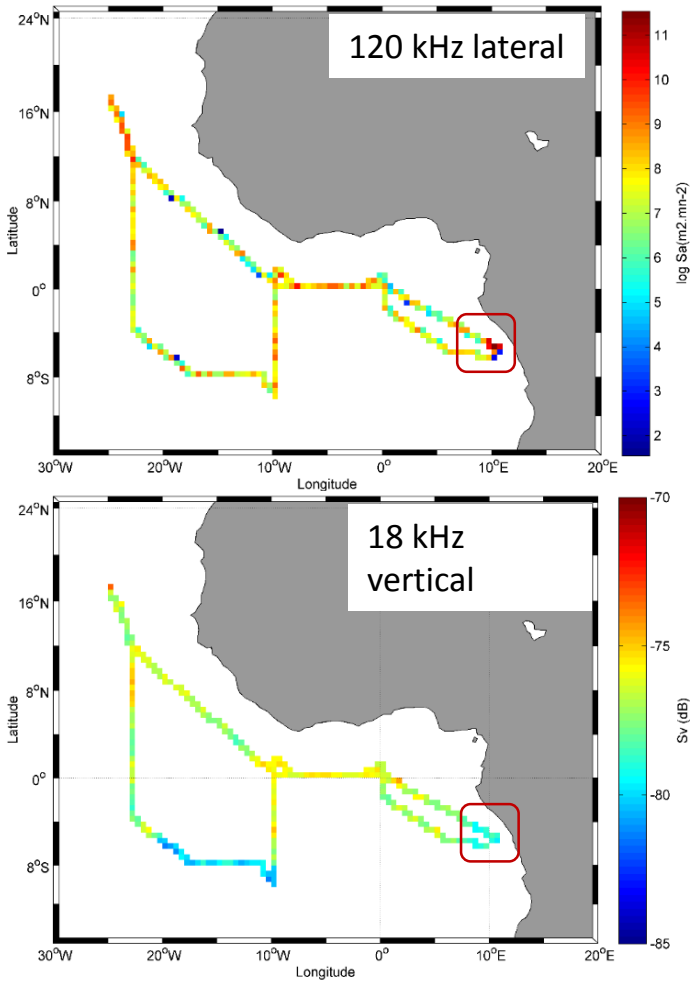
Acoustic data were echo-integrated onto 1 m layers over 0.1 nmi ESDU (elementary sampling distance unit)

Threshold: -100 dB
Range: 9 m (i.e. transducer depth + offset) down to 1000 m depth.

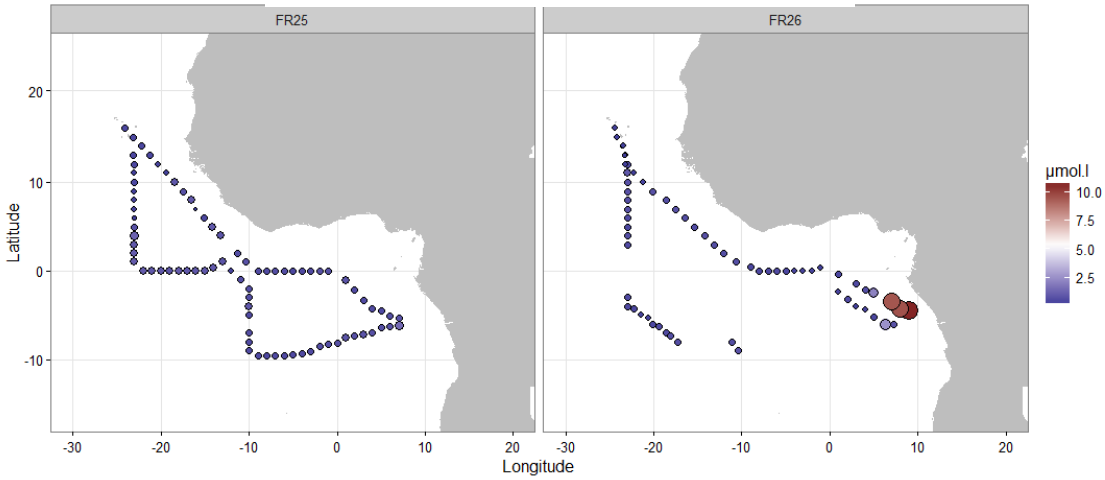
Threshold : -100 dB
Range : 20 m to 250 m.

Congo river plume impact

2016



Silicates concentration by survey



Strong water mass signal
⇒ More nutrients
⇒ Fish schools or high zooplankton density near the surface ?

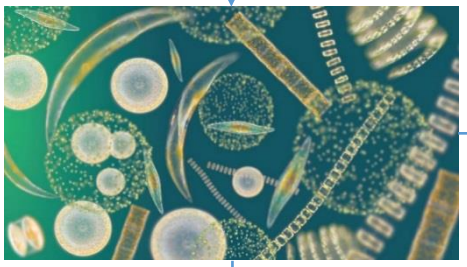
In progress:

- Study of zooplankton and phytoplankton samples
- Extraction of fish and zooplankton groups from acoustic data

Trophic food web

Light, circulation, temperature, nutrients

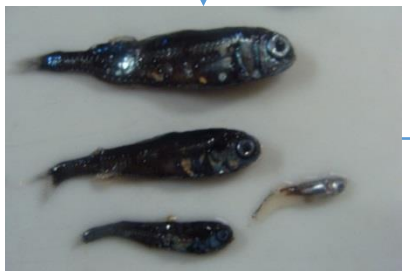
Phytoplankton



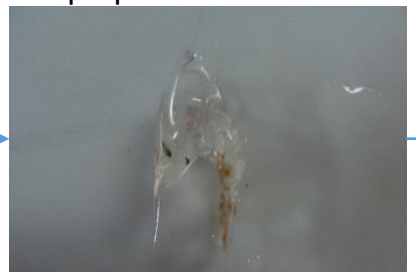
Copepods

Euphausiids

Myctophiids



Amphipods



Cephalopods

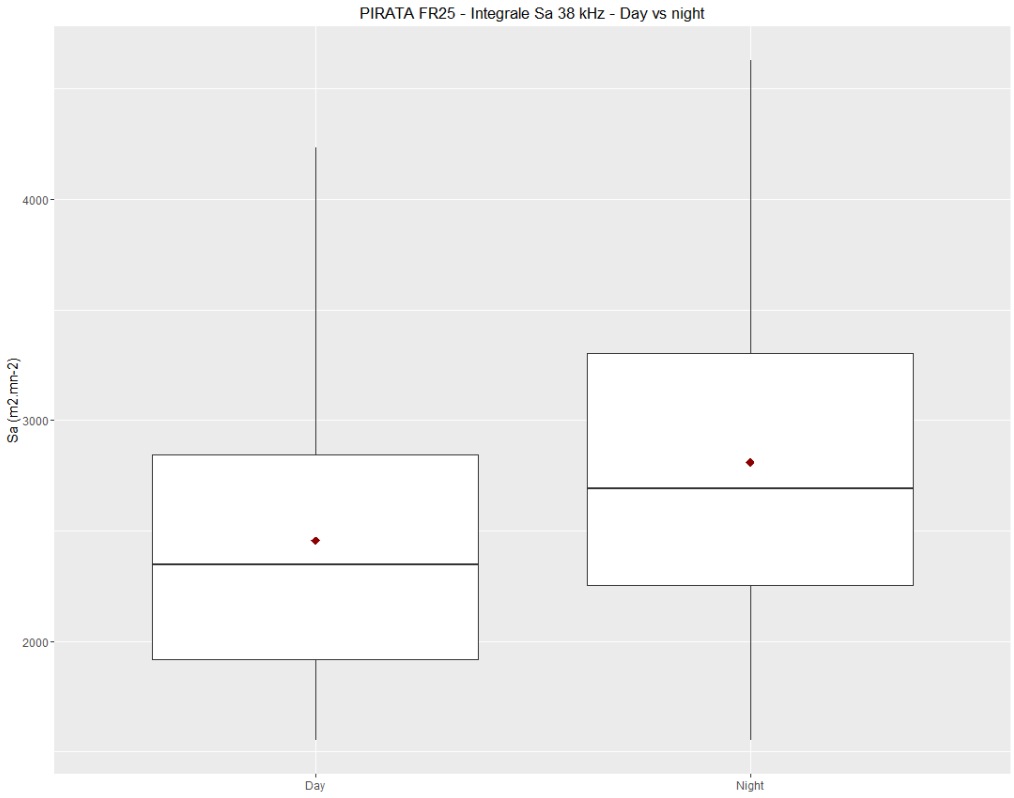
Small fish

Tuna

Wahoo

Sternoptyx

Mahi-mahi



intégrations globales sur 1000 m (18 kHz)
et 800 m (38 kHz)

Pour PIRATA FR25, les ratios sont :
- 18 kHz : 1.38
- 38 kHz : 1.39

Les ratios sont un peu plus faibles sur PIRATA FR26,
- 18 kHz : 1.29
- 38 kHz : 1.13

Donc il y a sans doute des migrations d'organismes venant de plus profond que 1000 m ?

Problème de TVG mal compensée de jour ?

Orientation des poissons (tilt angle) en vertical de jour ?