First insights on the impact of hydrology and currents on the horizontal and vertical distributions of fish and macrozooplankton in the Eastern tropical Atlantic Ocean



Paris, November 29th, 2016

Habasque Jérémie, Bourlès Bernard, Machu Eric, Brehmer Patrice, Bertrand Arnaud

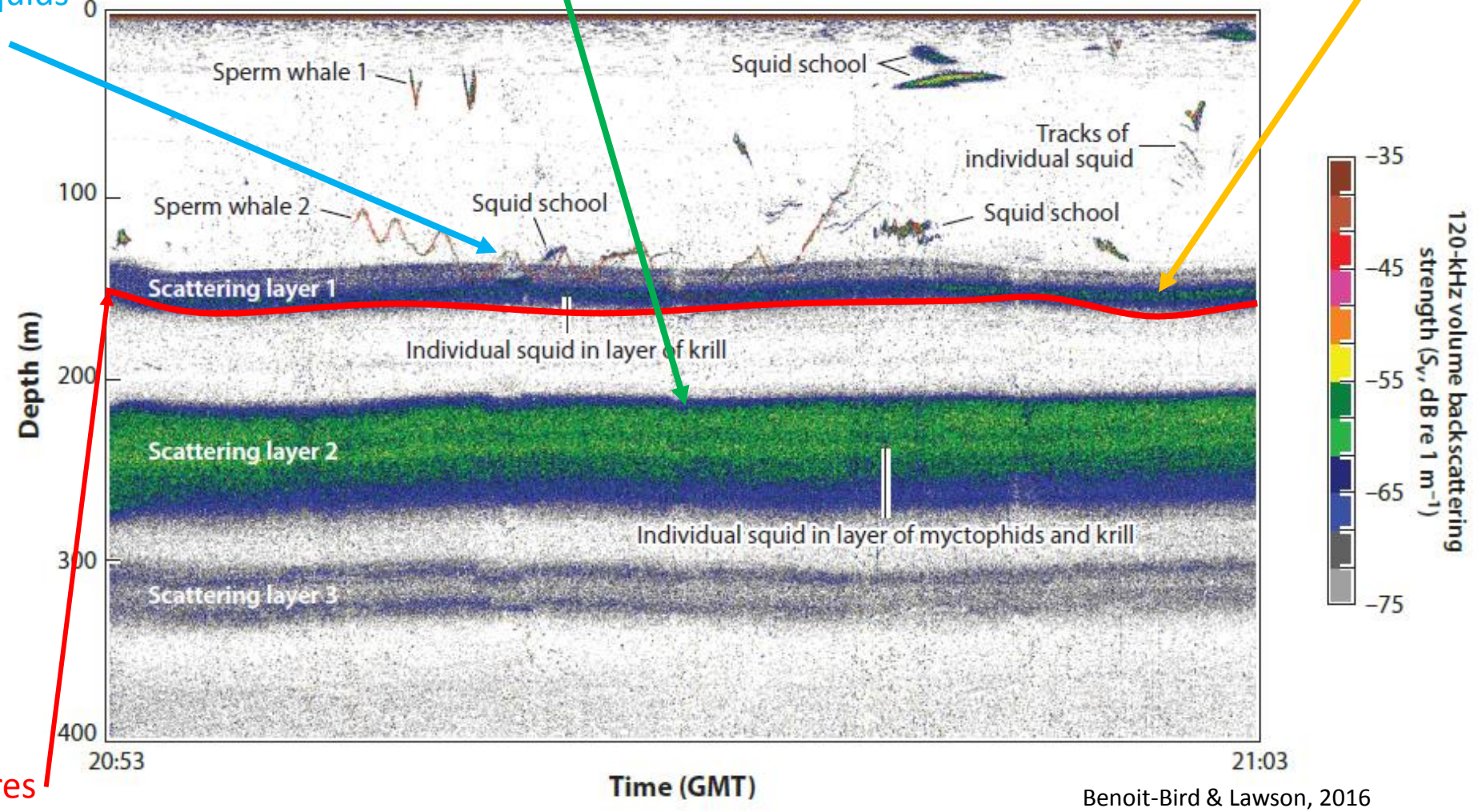
Institut de Recherche pour le Développement FRANCE

jeremie.habasque@ird.fr

Squids eat myctophids and krill

Zooplankton layer, identification with Bongo

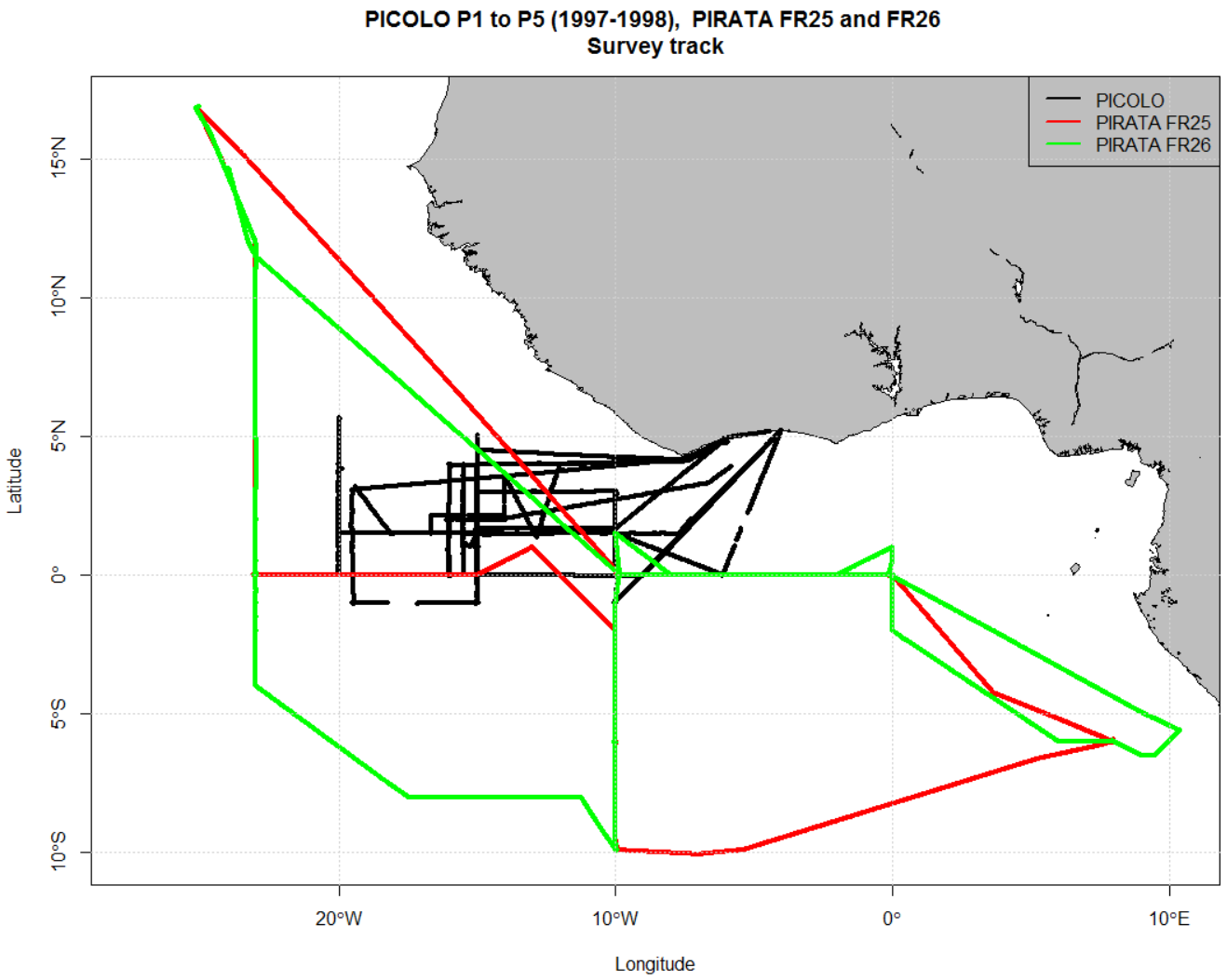
Mammals eat squids



Physical structures
(Ex. thermocline, internal waves, etc.)

Benoit-Bird & Lawson, 2016

Introduction



Few acoustics data since PICOLO cruises (1997-1998)

Since 2015, data collected during PIRATA cruises

➔ **Need to explore these data !**

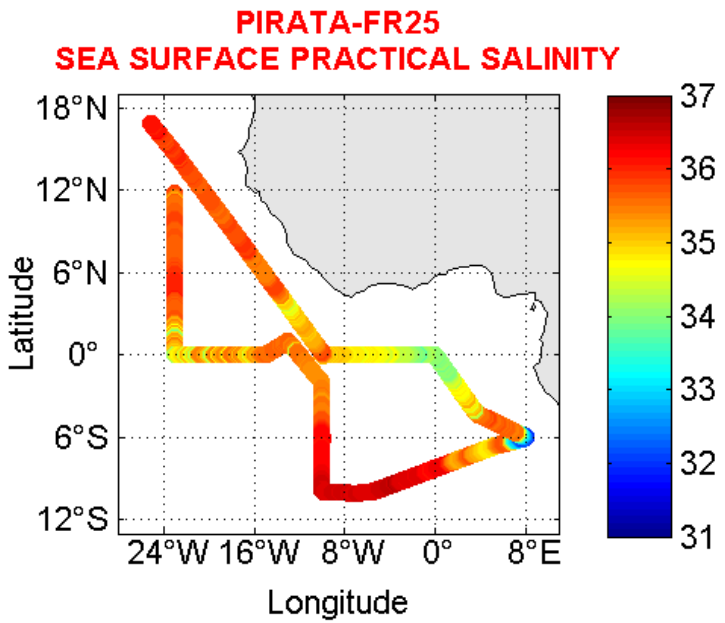
Questions

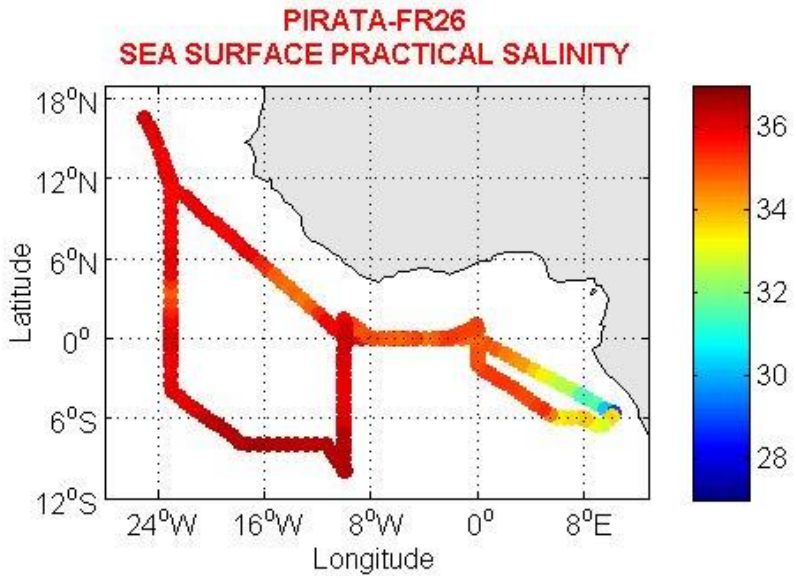
- Potential influence of the vertical structure (including thermocline, oxycline and peak of fluorescence) on the **vertical patterns** of organisms distribution ?

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

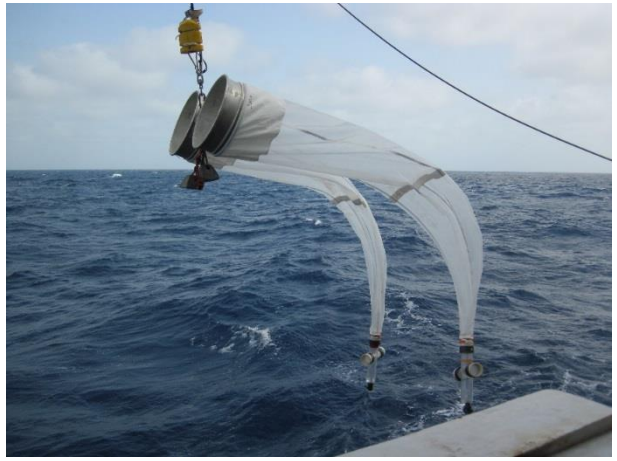
Surveys and data used

Characterization of water masses :
Thermosalinograph, CTD-O2, nutrients and pigments, SADCP

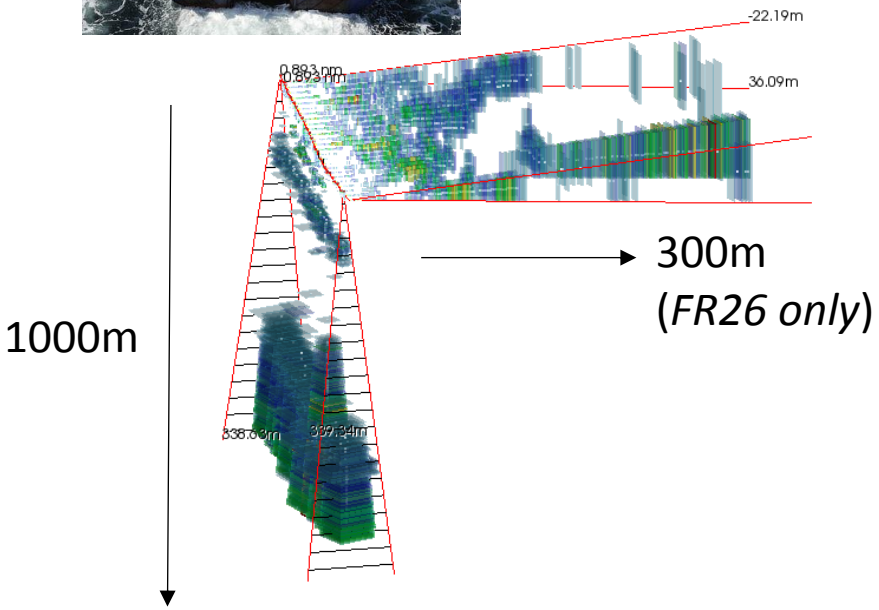




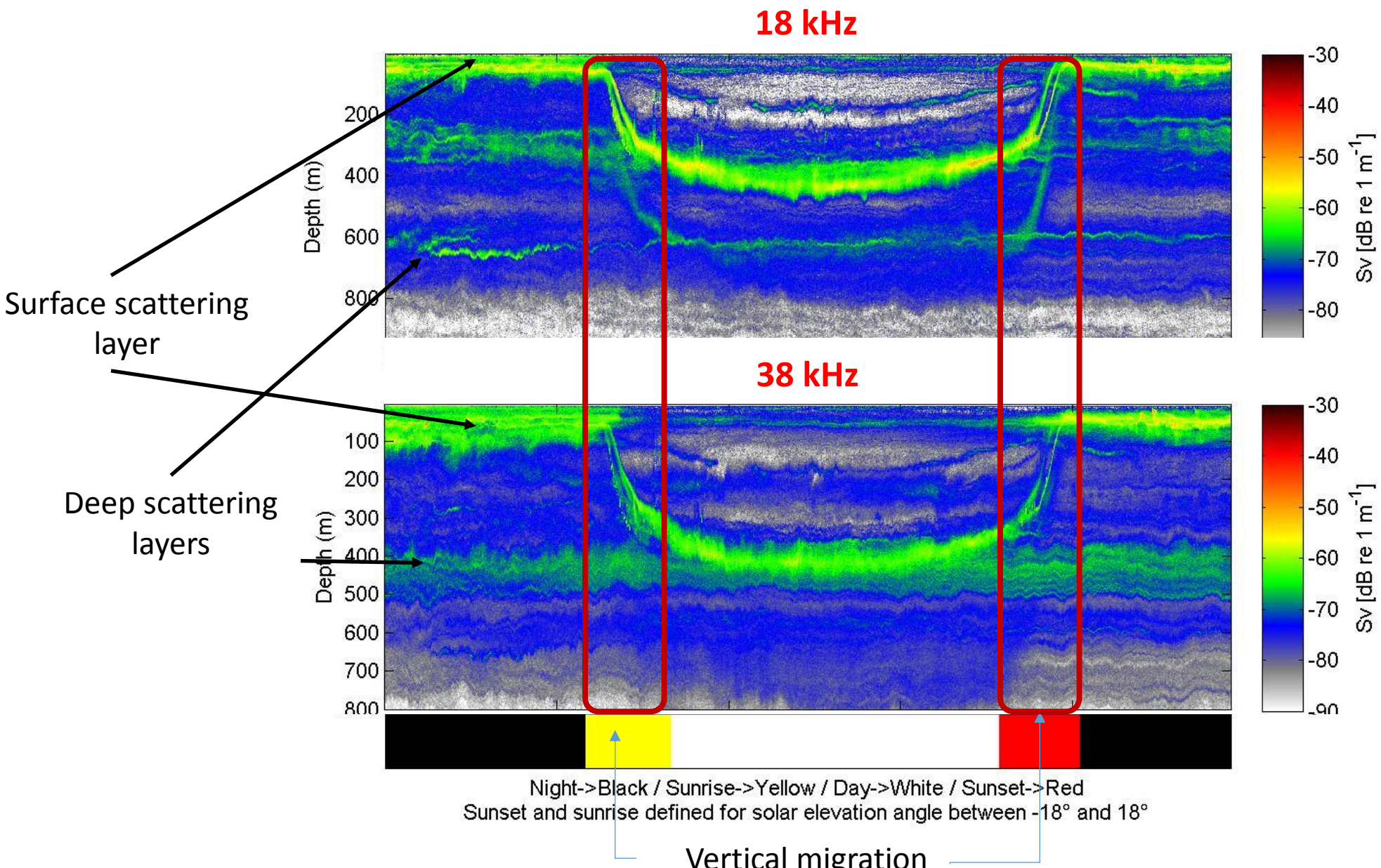
Plankton net (Bongo 300 µm) from 200 m to the surface *(FR26 only)*



Ecosystem acoustics:
18, 38, 70, 120, 200, 333 kHz

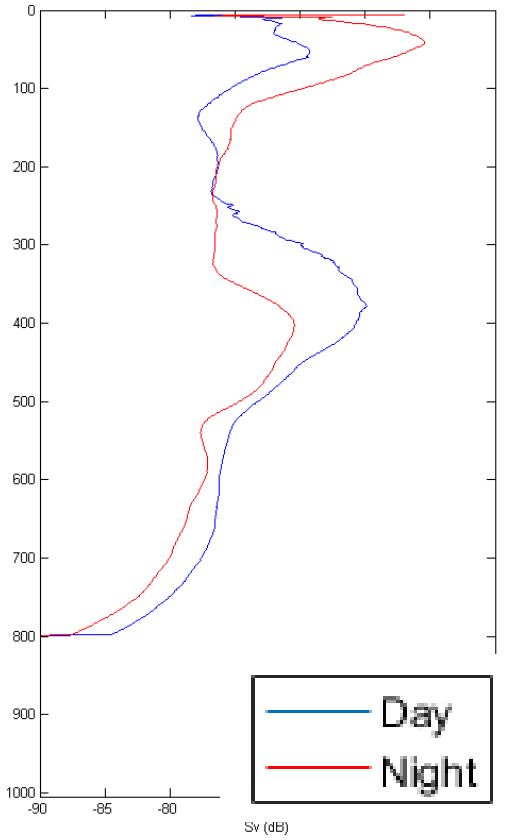


Example of a 24h registration



Global mean acoustic vertical profiles

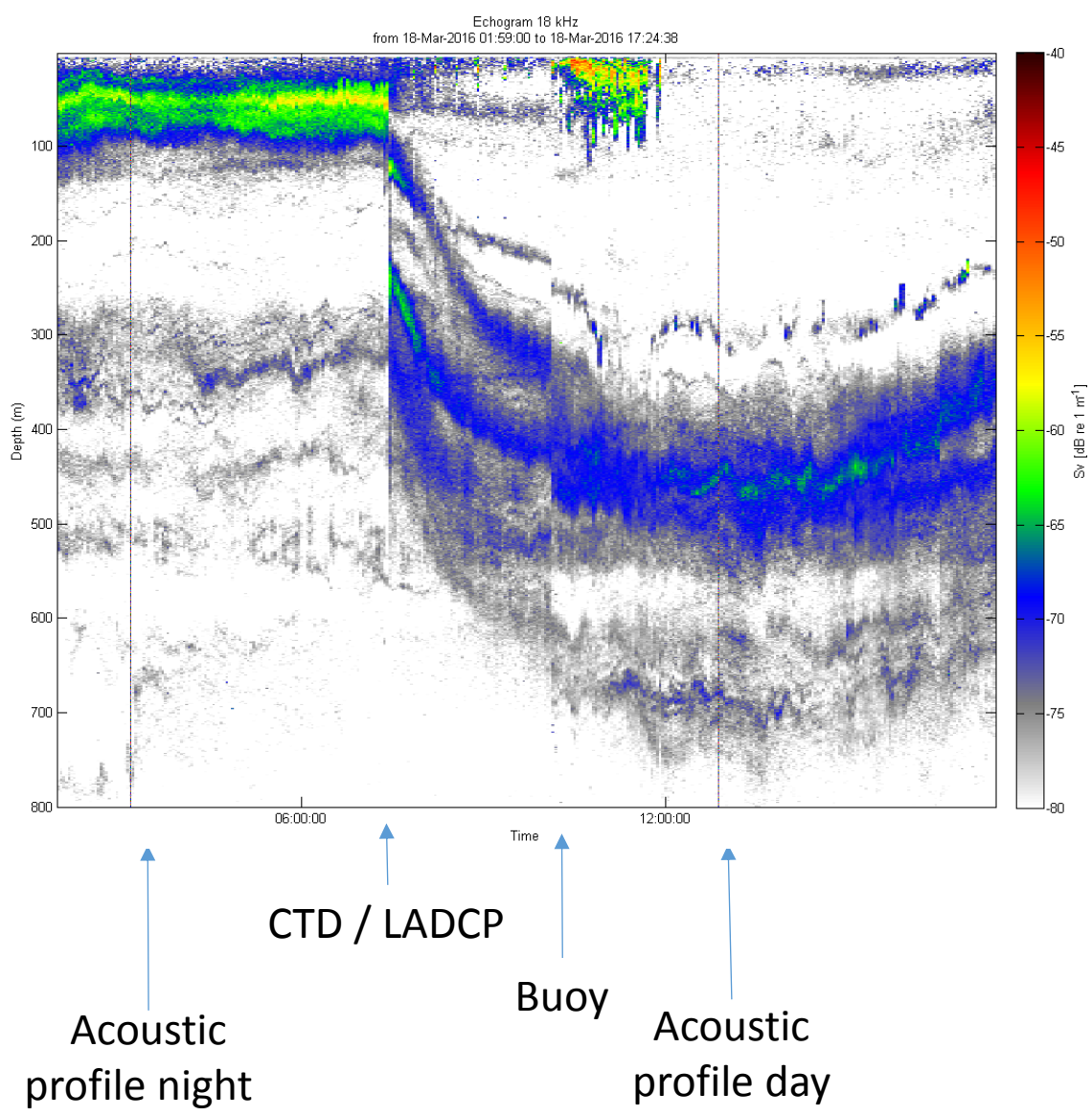
FR26: 38kHz



Light is a key driver

Vertical distribution and hydrology

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

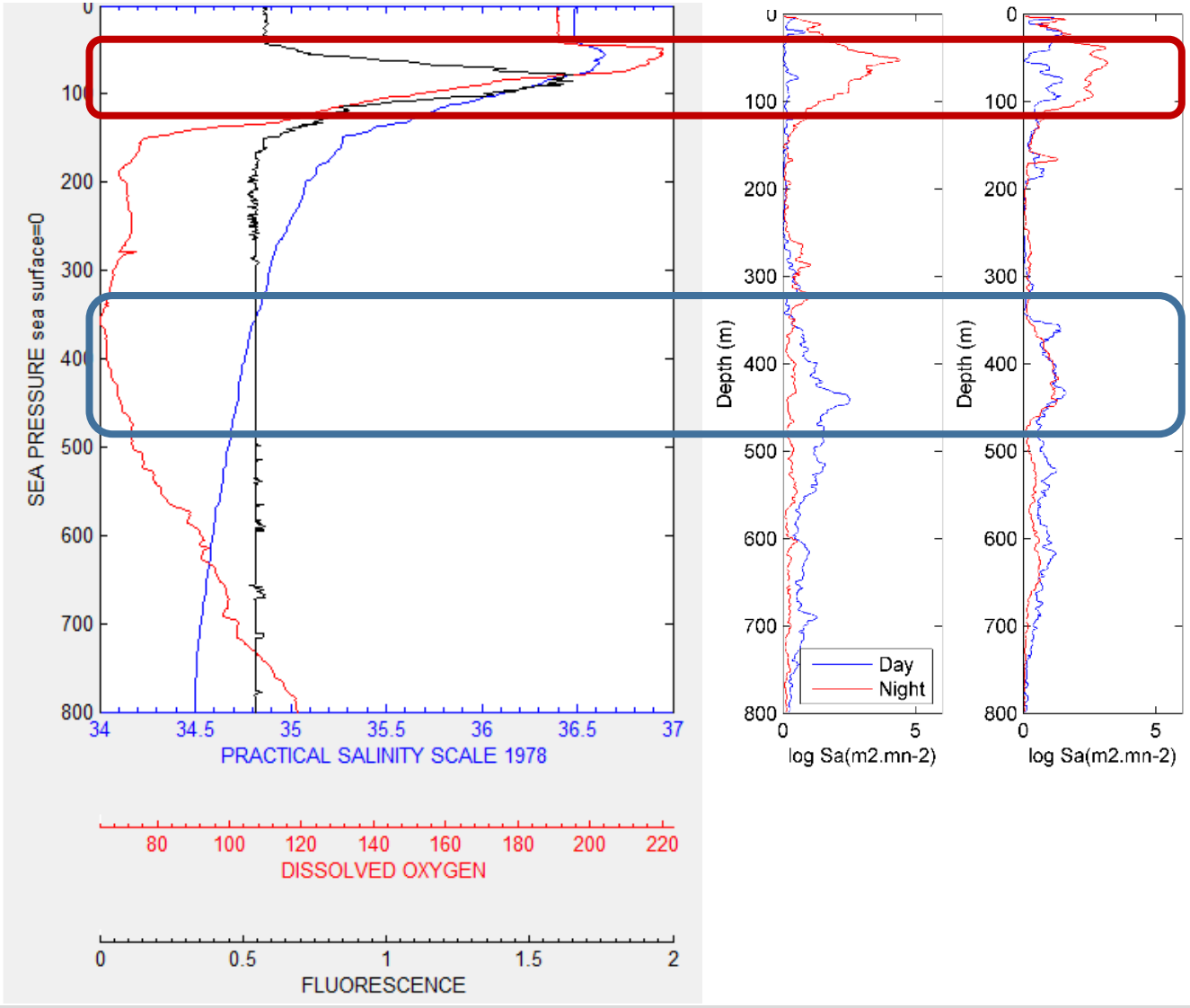


Acoustic profile

CTD profile

18kHz

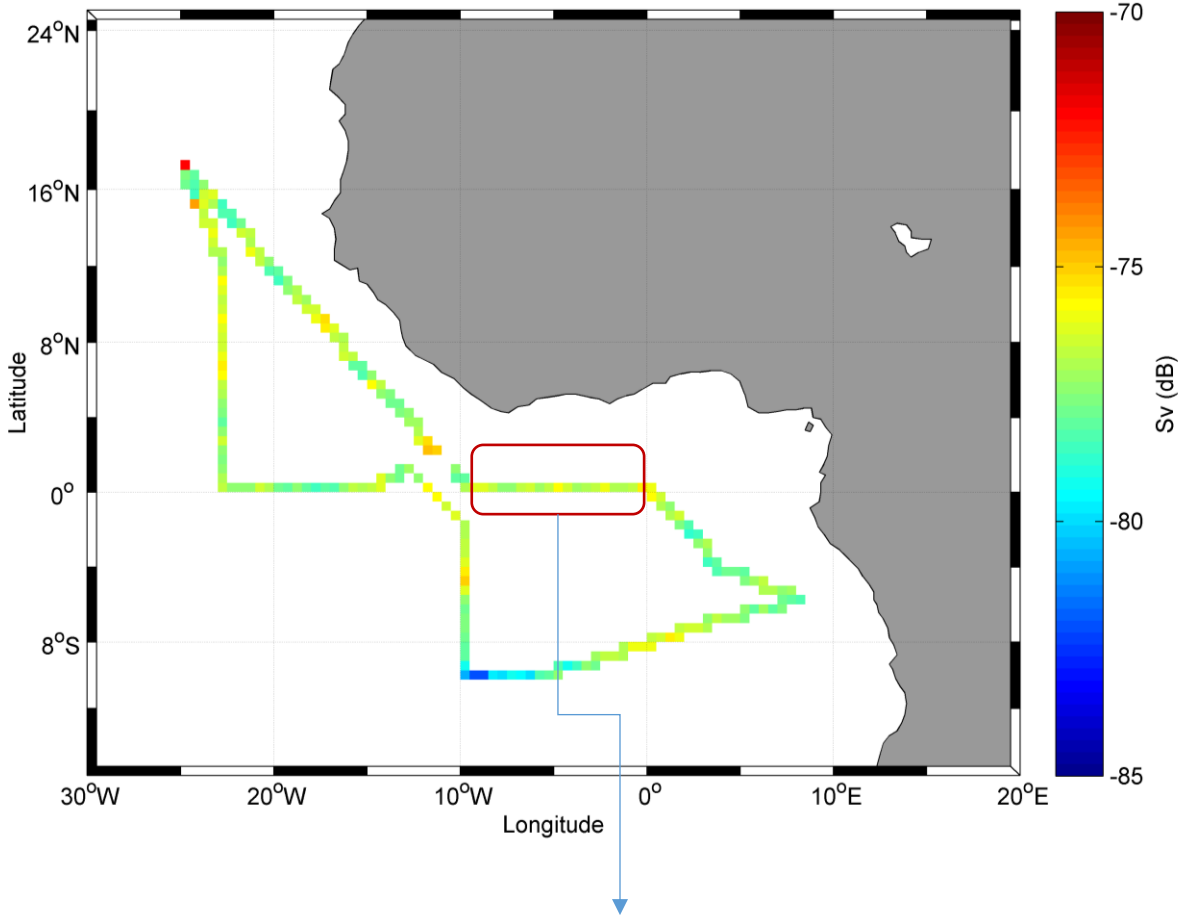
38kHz



During day, low oxygen zone is a refuge for hypoxia tolerant species

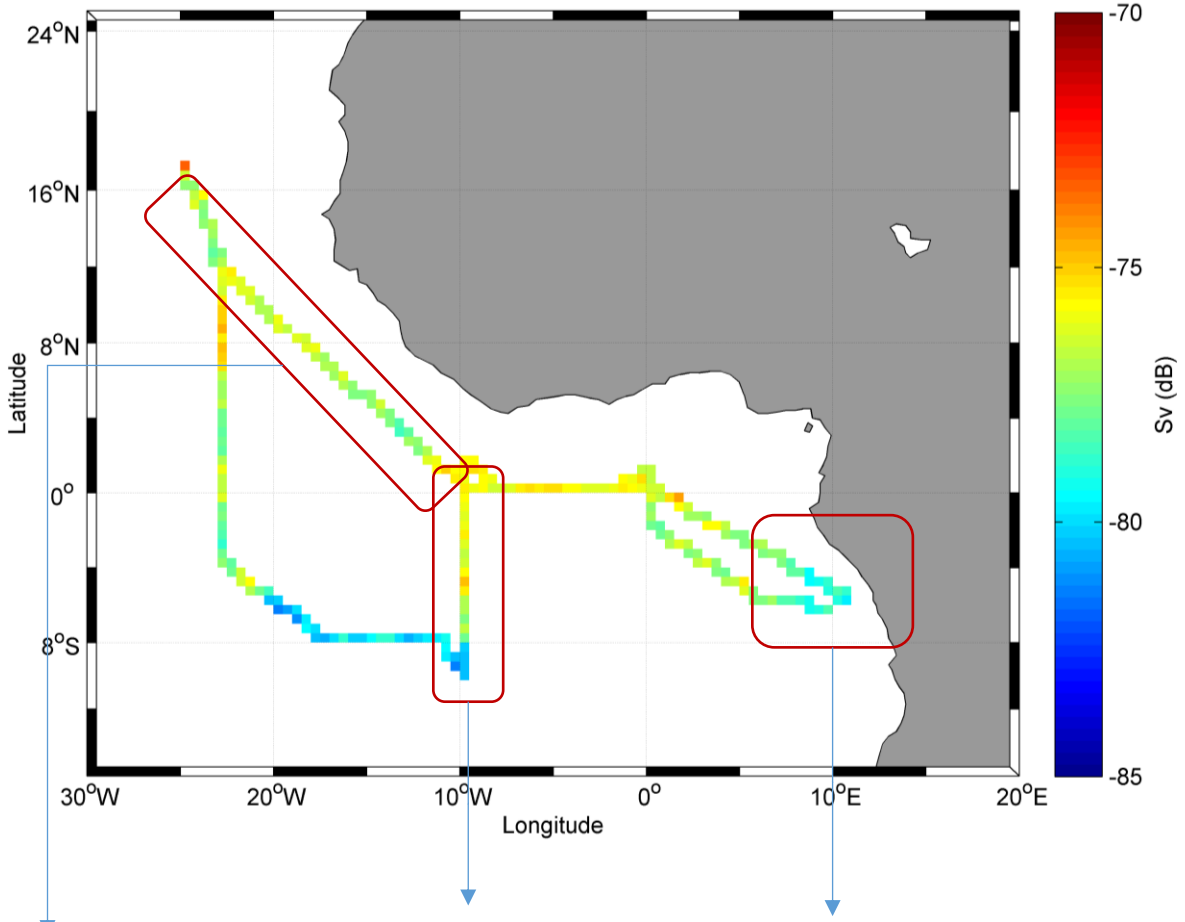
Horizontal distribution patterns : mean backscatter of the whole water column at 18kHz

2015



Equatorial section

2016



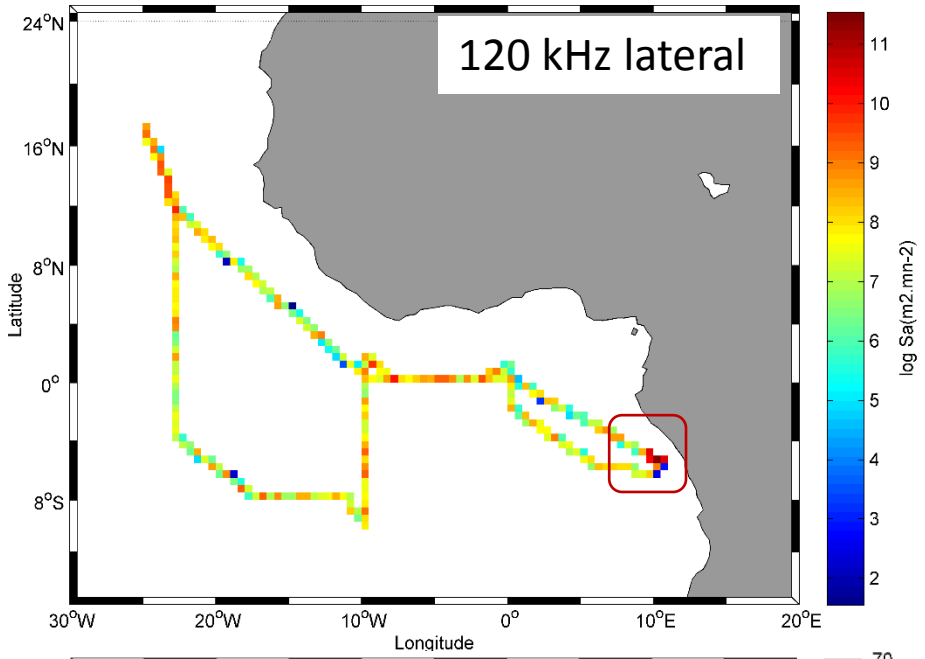
0°N-10°W to Mindelo

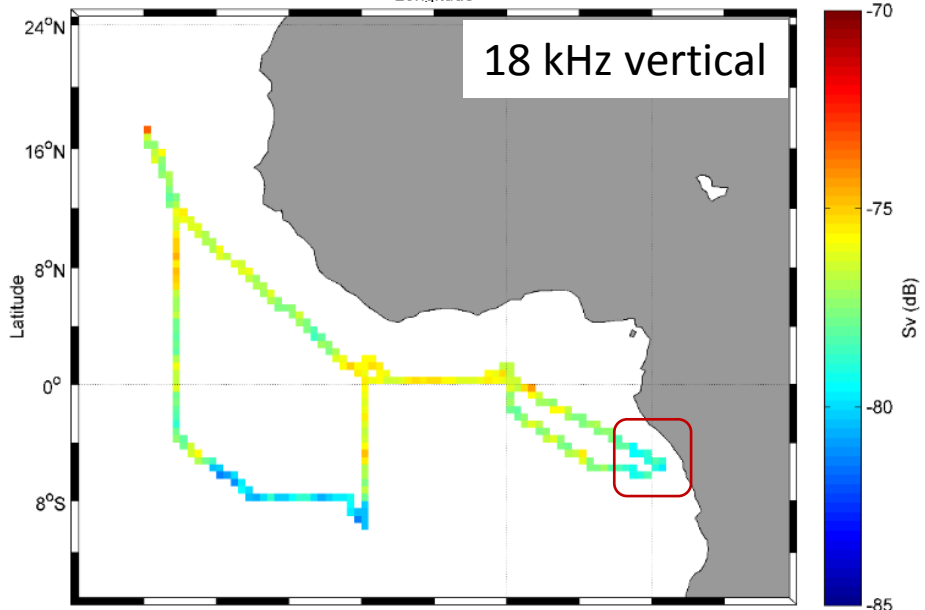
Main CTD section

Congo river plume

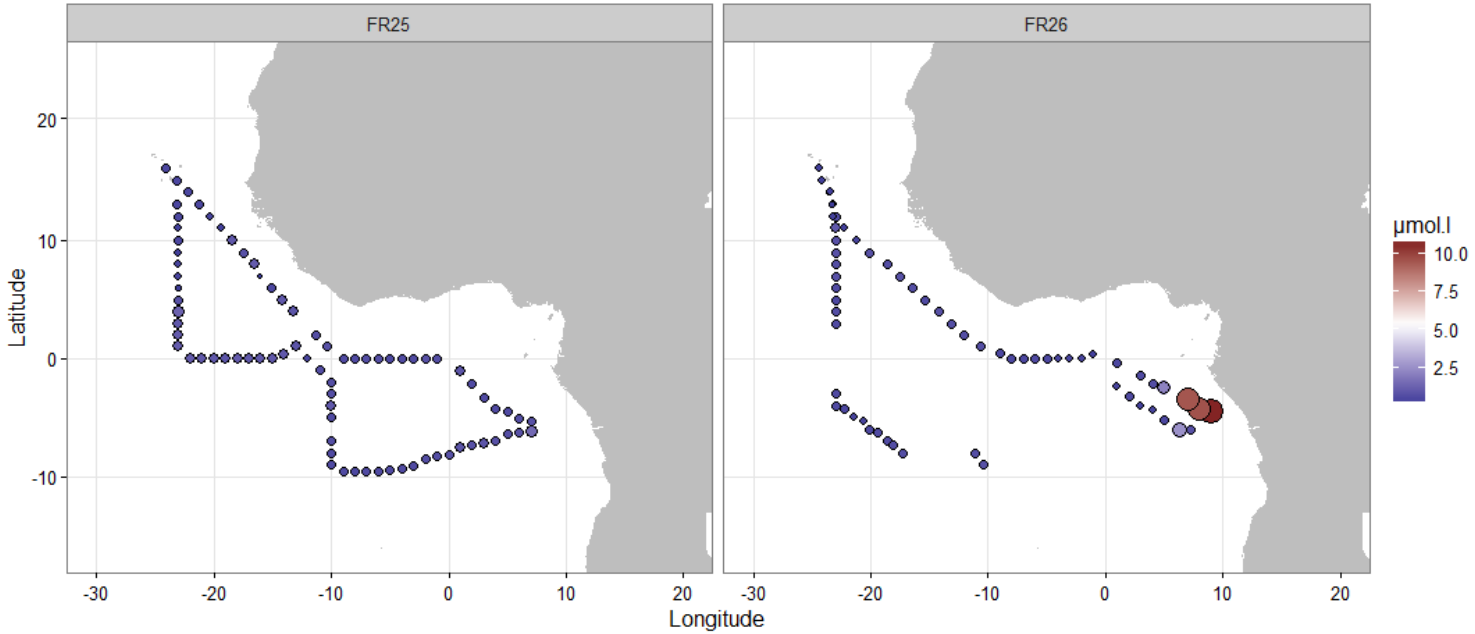
Congo river plume impact

2016





Silicates concentration by survey



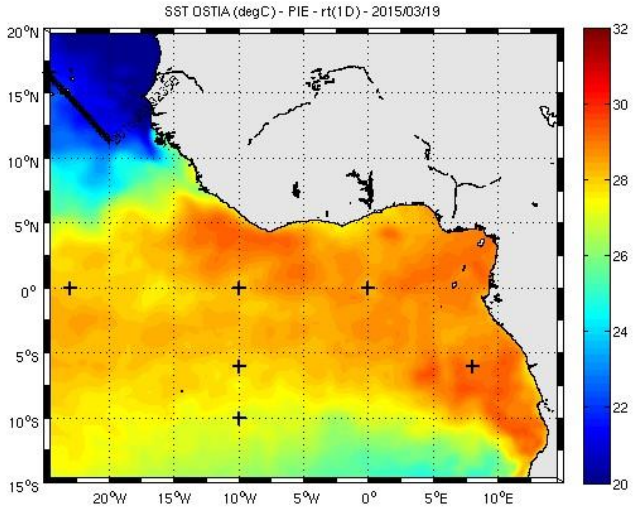
Strong water mass signal
⇒ More nutrients
⇒ Fish schools or high zooplankton density near the surface ?

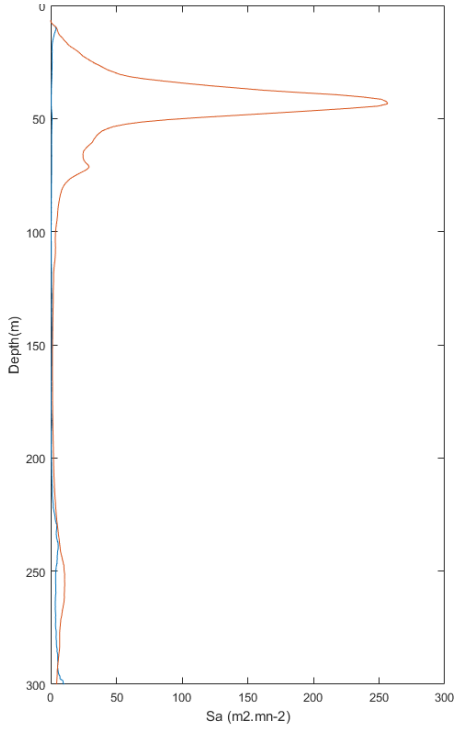
In progress:

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

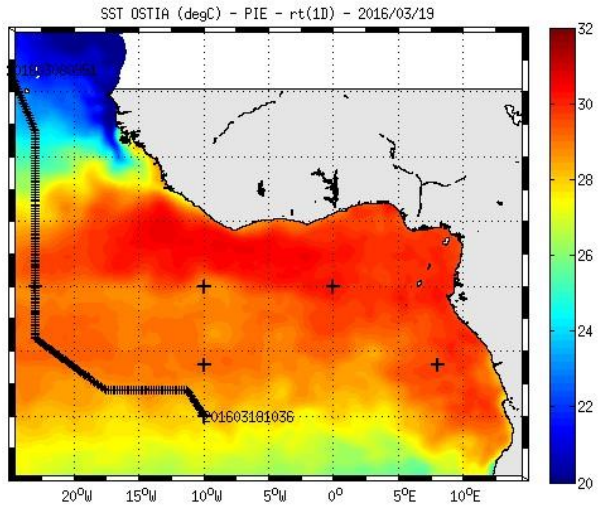
Equatorial section and upwelling impact

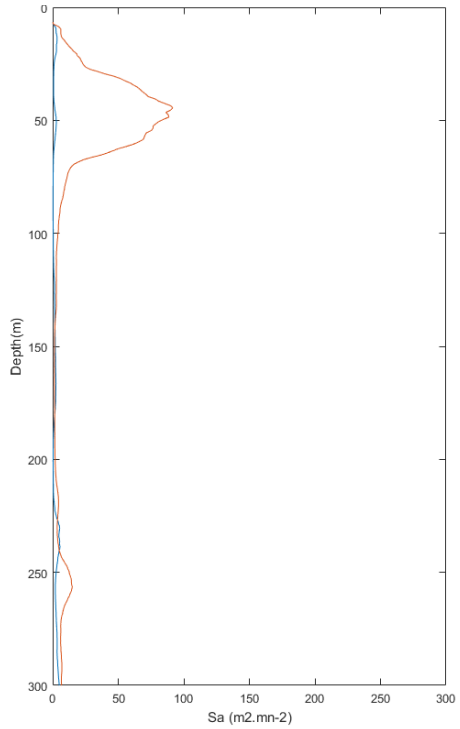
2015

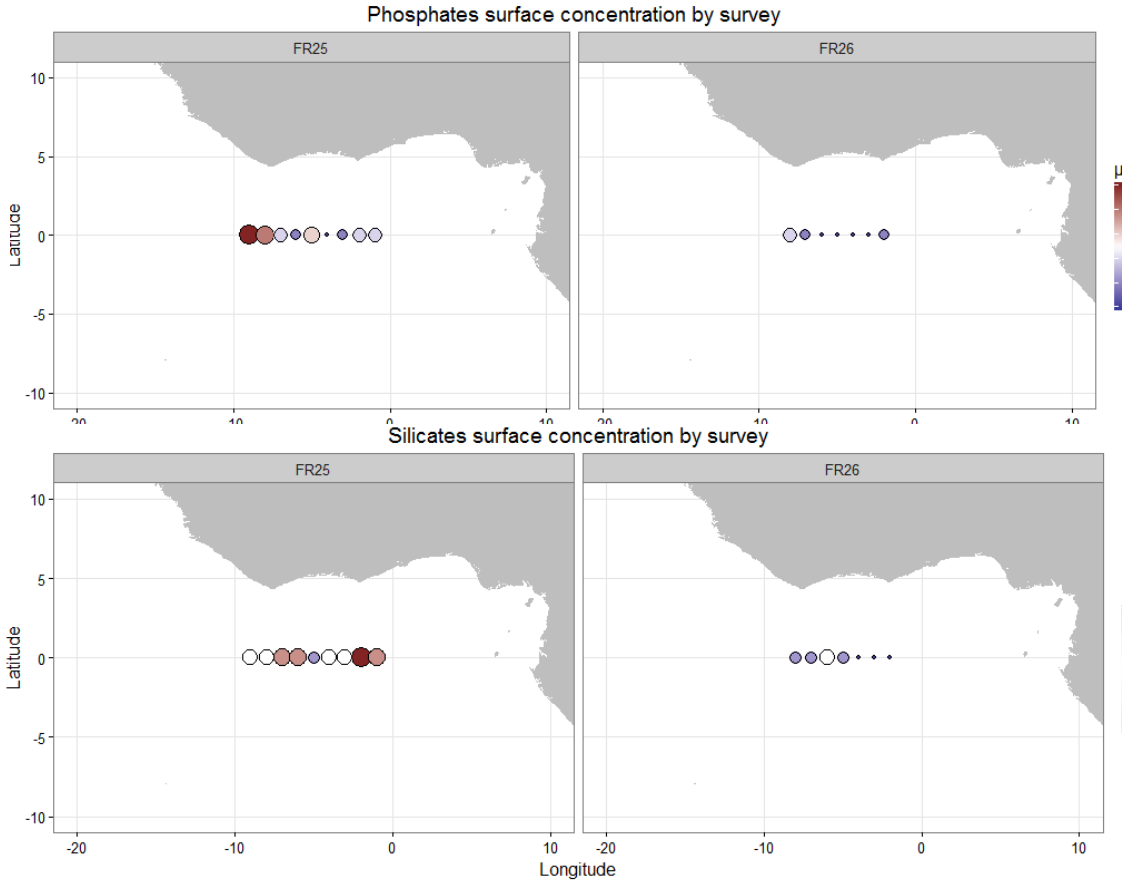




2016







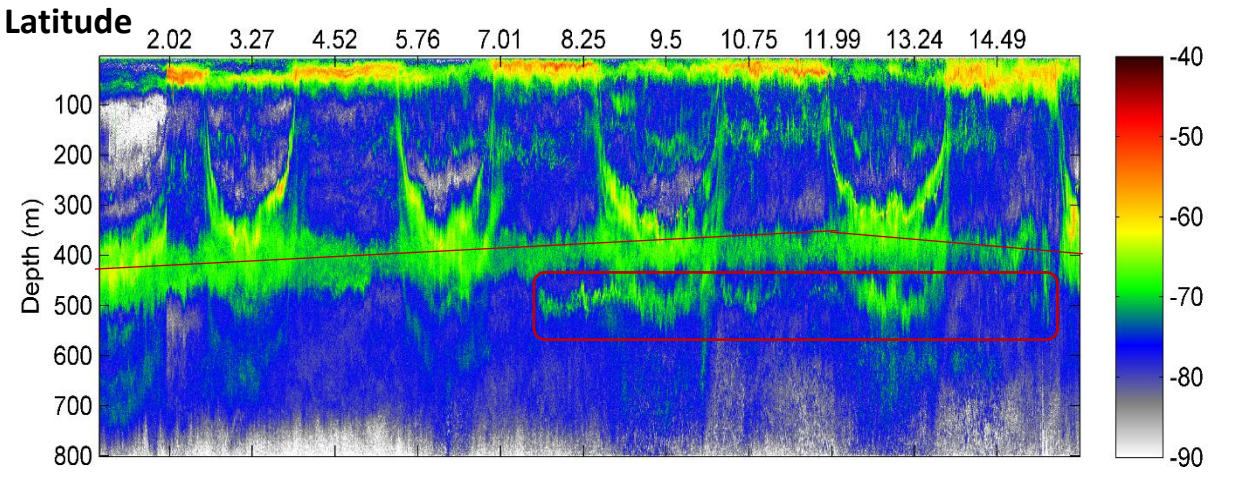
Colder SST and shallower thermocline in 2015
⇒ More nutrients
⇒ Higher acoustic density

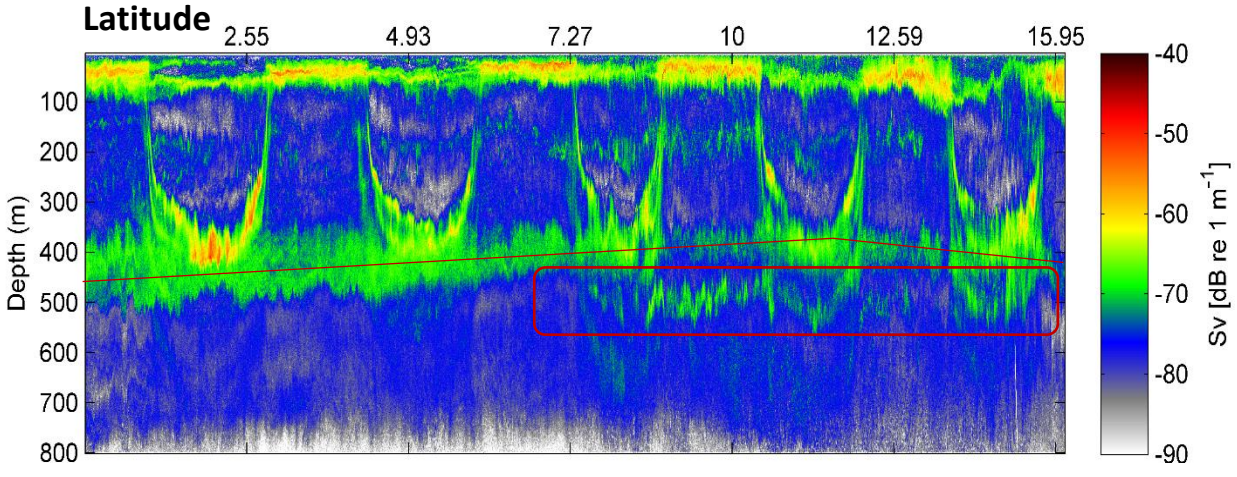
Section 0°N-10°W to Mindelo

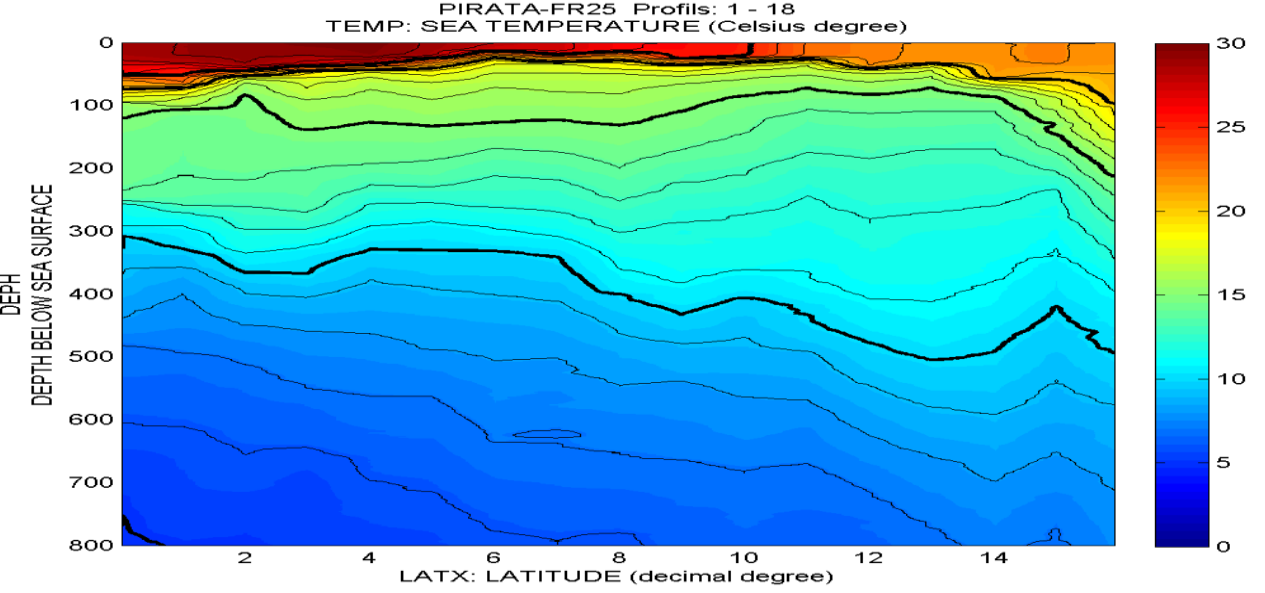
2015

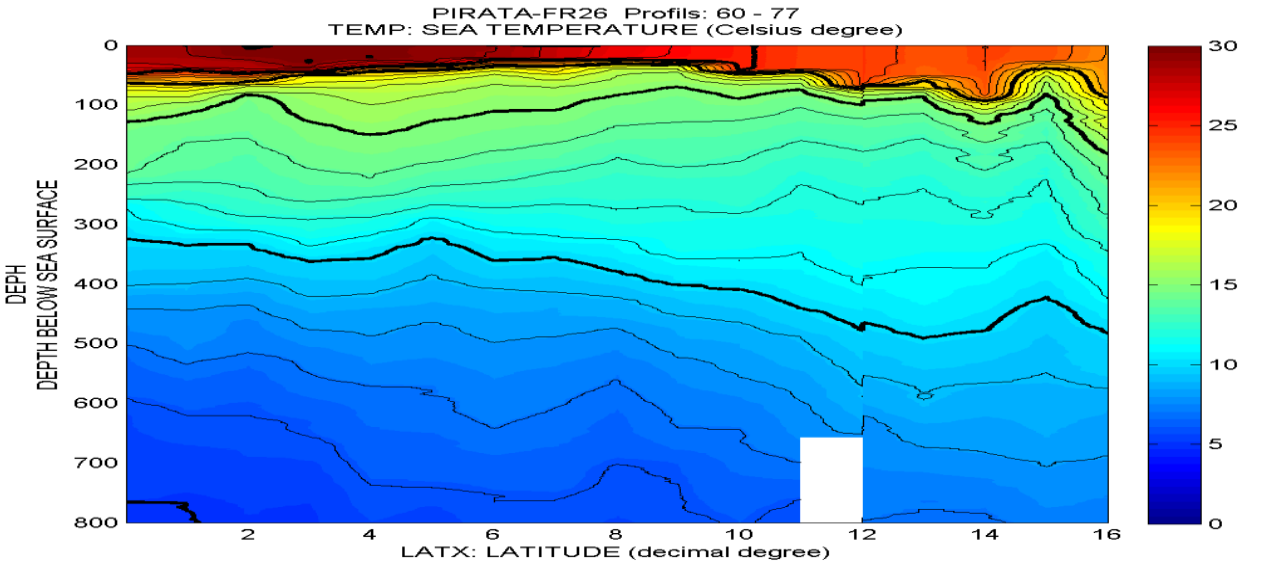
2016

Echogram at 38kHz



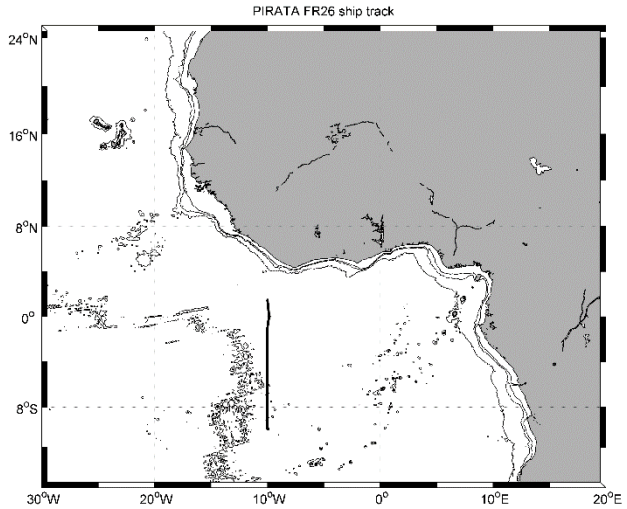


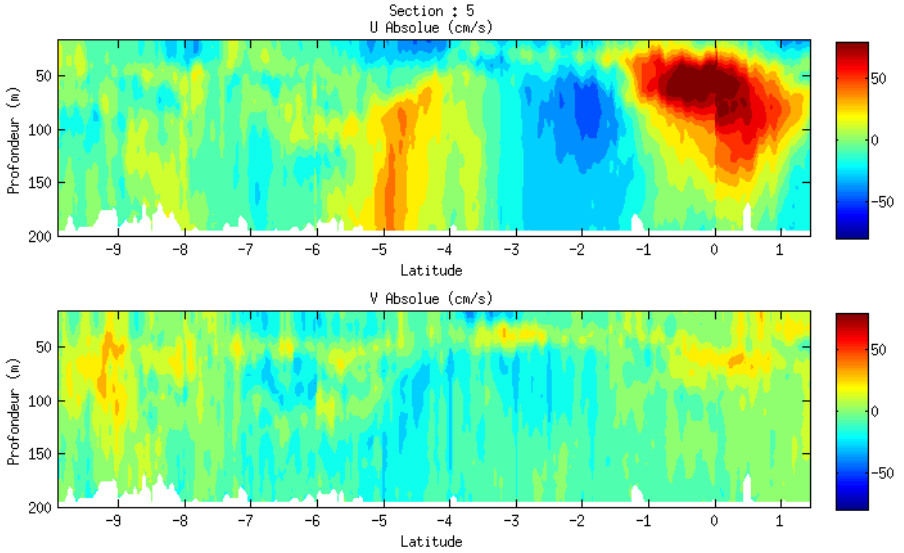




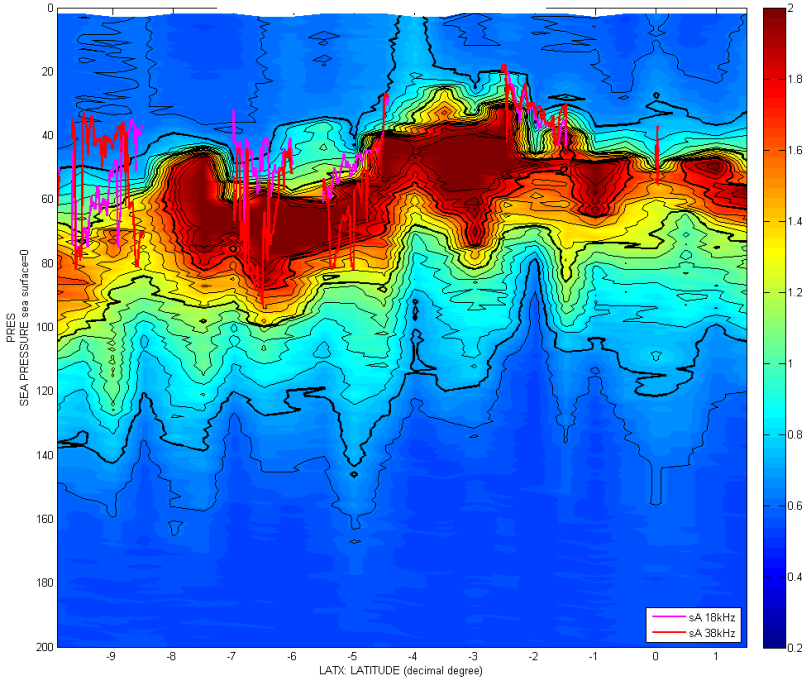
Oxygen involved in the change of vertical distribution ?

10°W section - Organisms density and environment

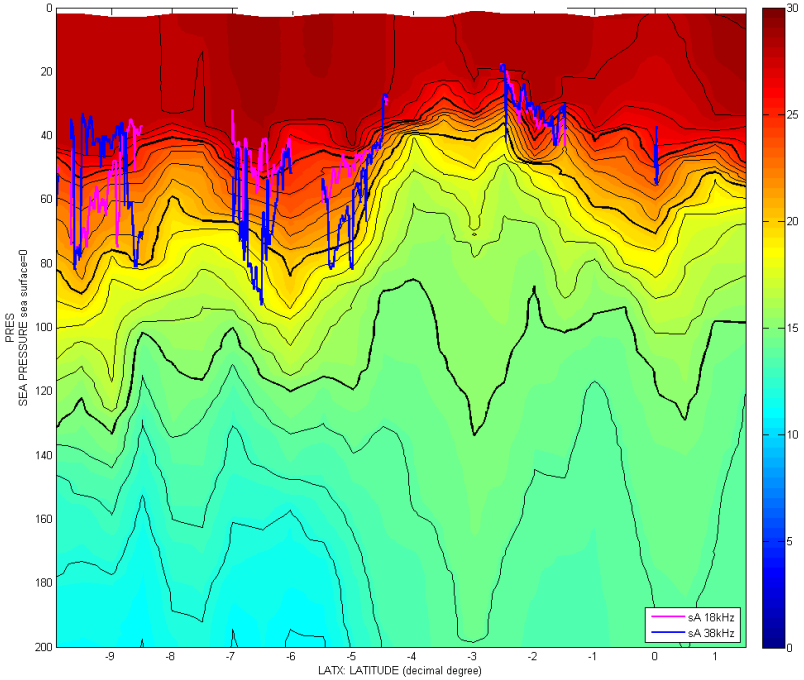




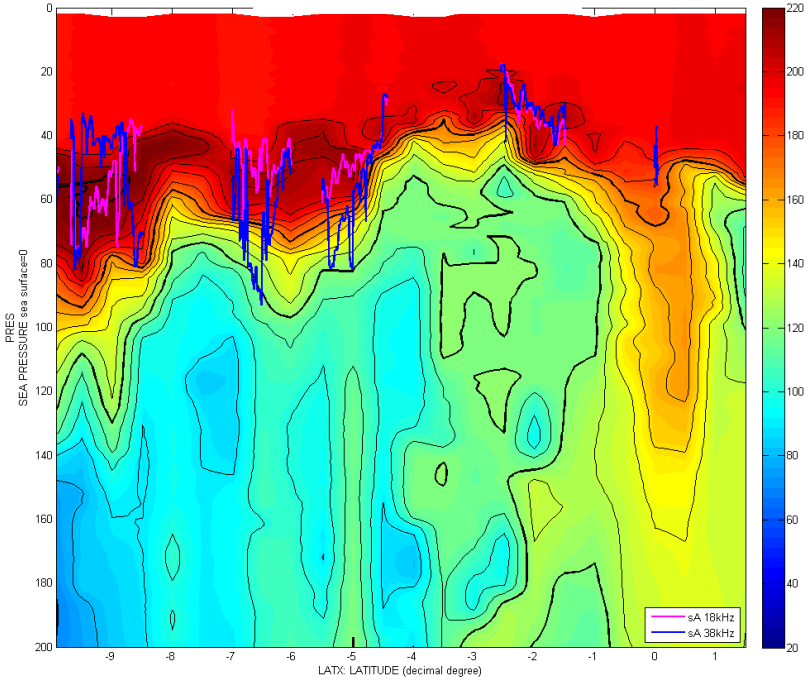
Fluorescence



Temperature



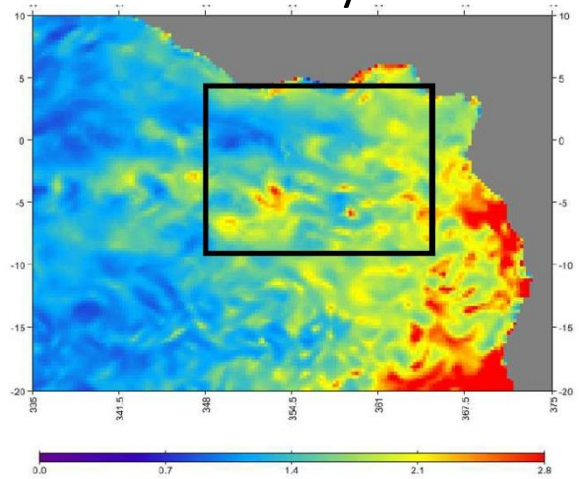
Oxygen



Short term perspectives

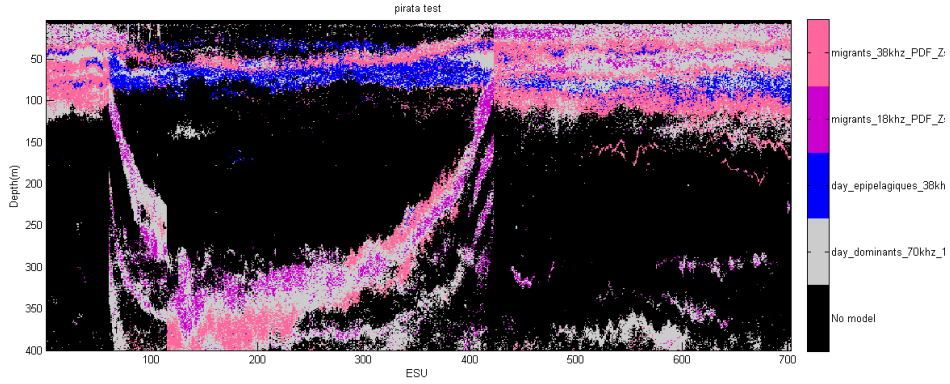
- More accurate analysis of hydrology/currents impact on organisms distribution

- Seapodym model validation
(acoustic data used by CLS in the frame of AtlantOS)



- PIRATA FR27 cruise => if Sargassum banks, potential use of lateral echosounder

- Plankton species identification and organisms classification using multifrequency data



All information about fishes & plankton identification in the area are welcome !!!

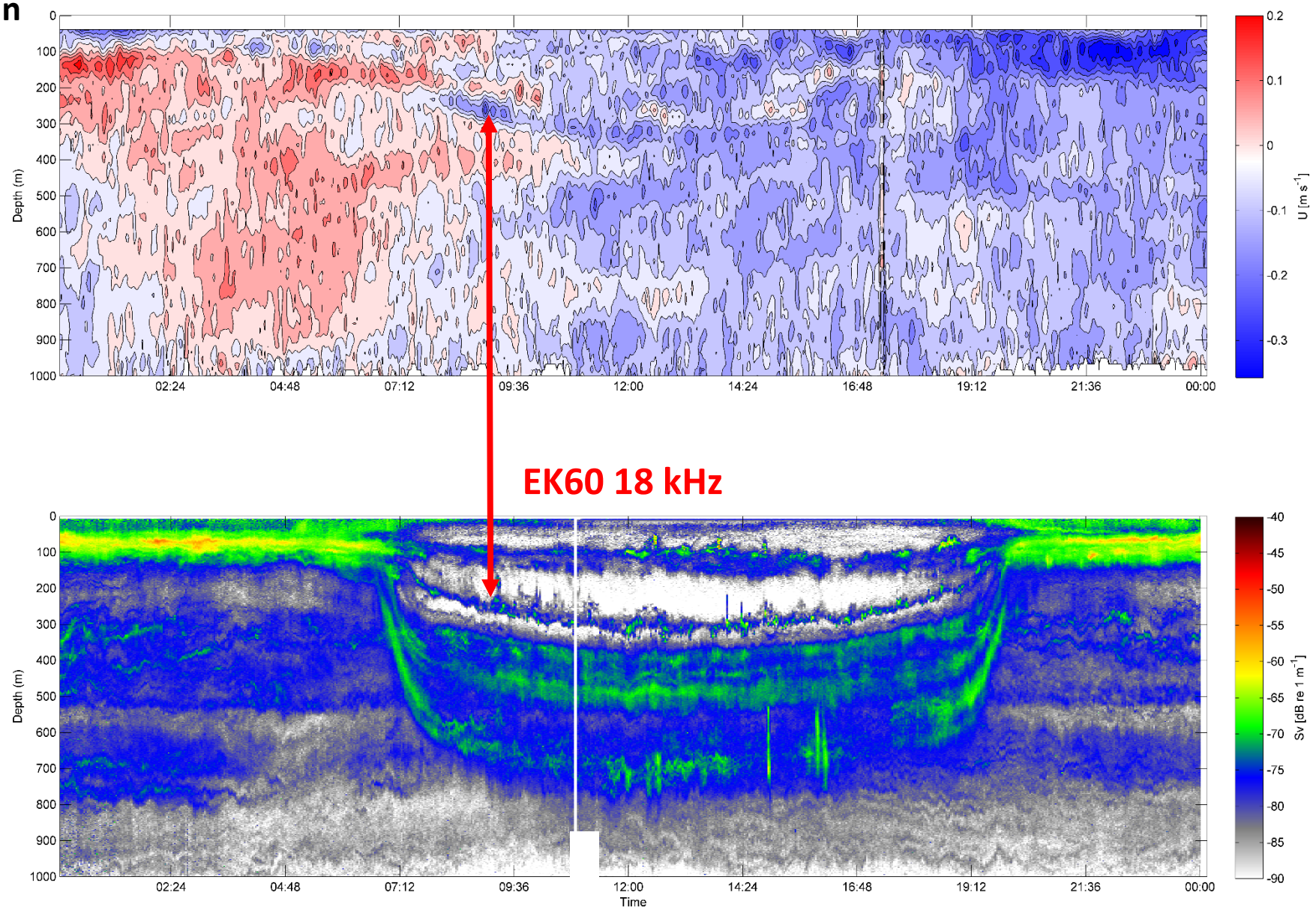
Thank you!

Acknowledgements:

This work is also supported by the EU AtlantOS project.

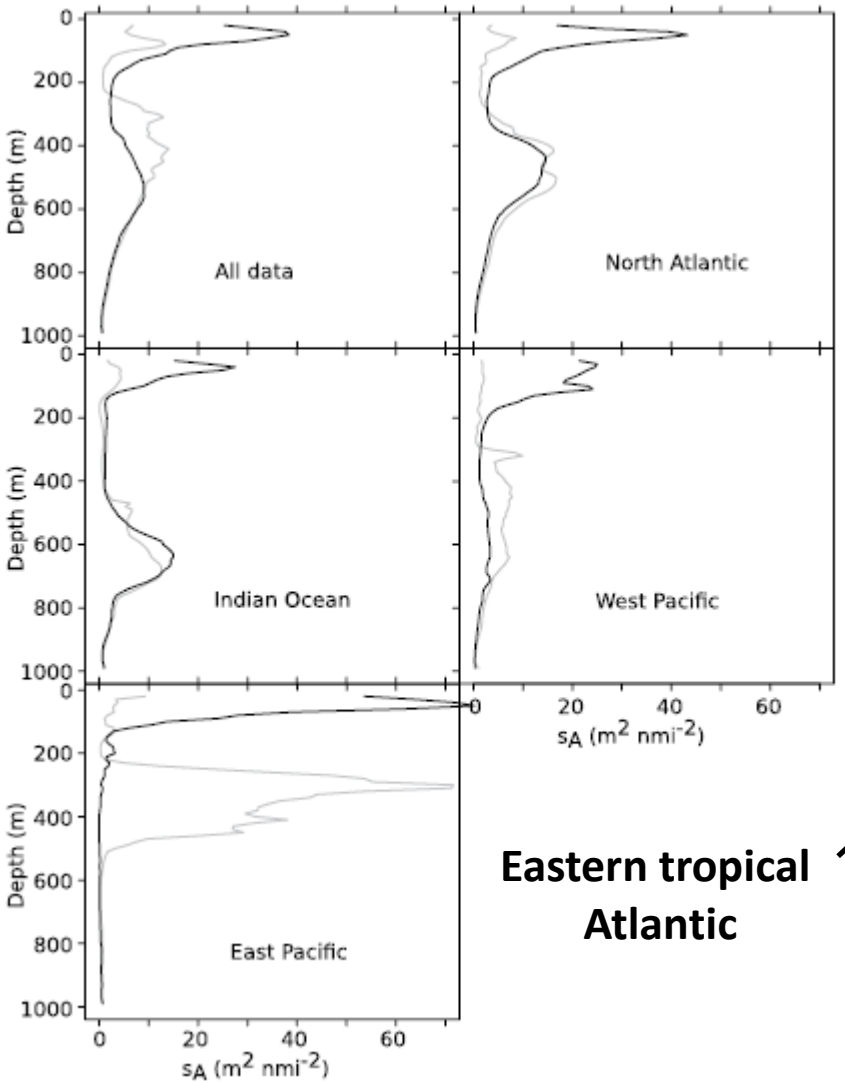
Open question !

Location : 8°S
Time resolution : 2 min



Vertical distribution patterns

Vertical acoustic density patterns

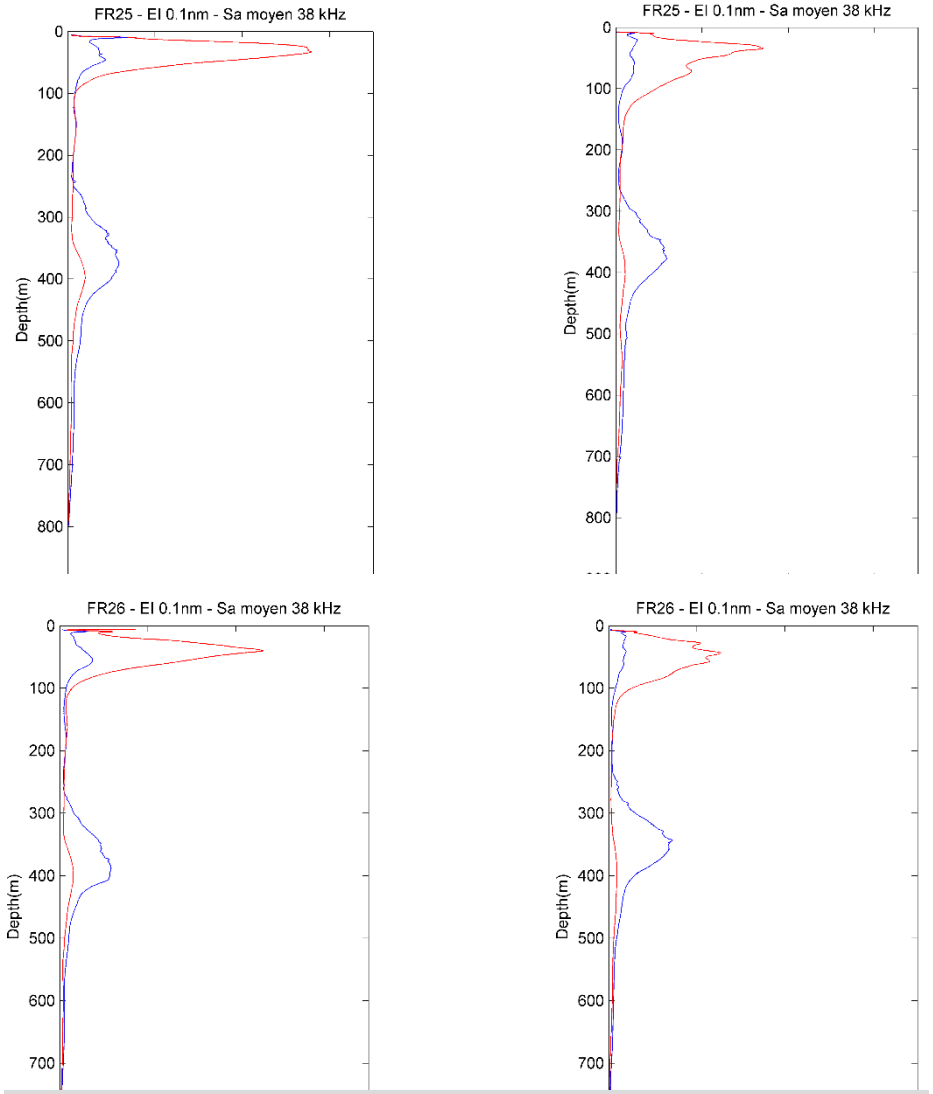


Klevjer, T. A. et al. (2016).

Eastern tropical Atlantic

North to 2°N

South to 2°S

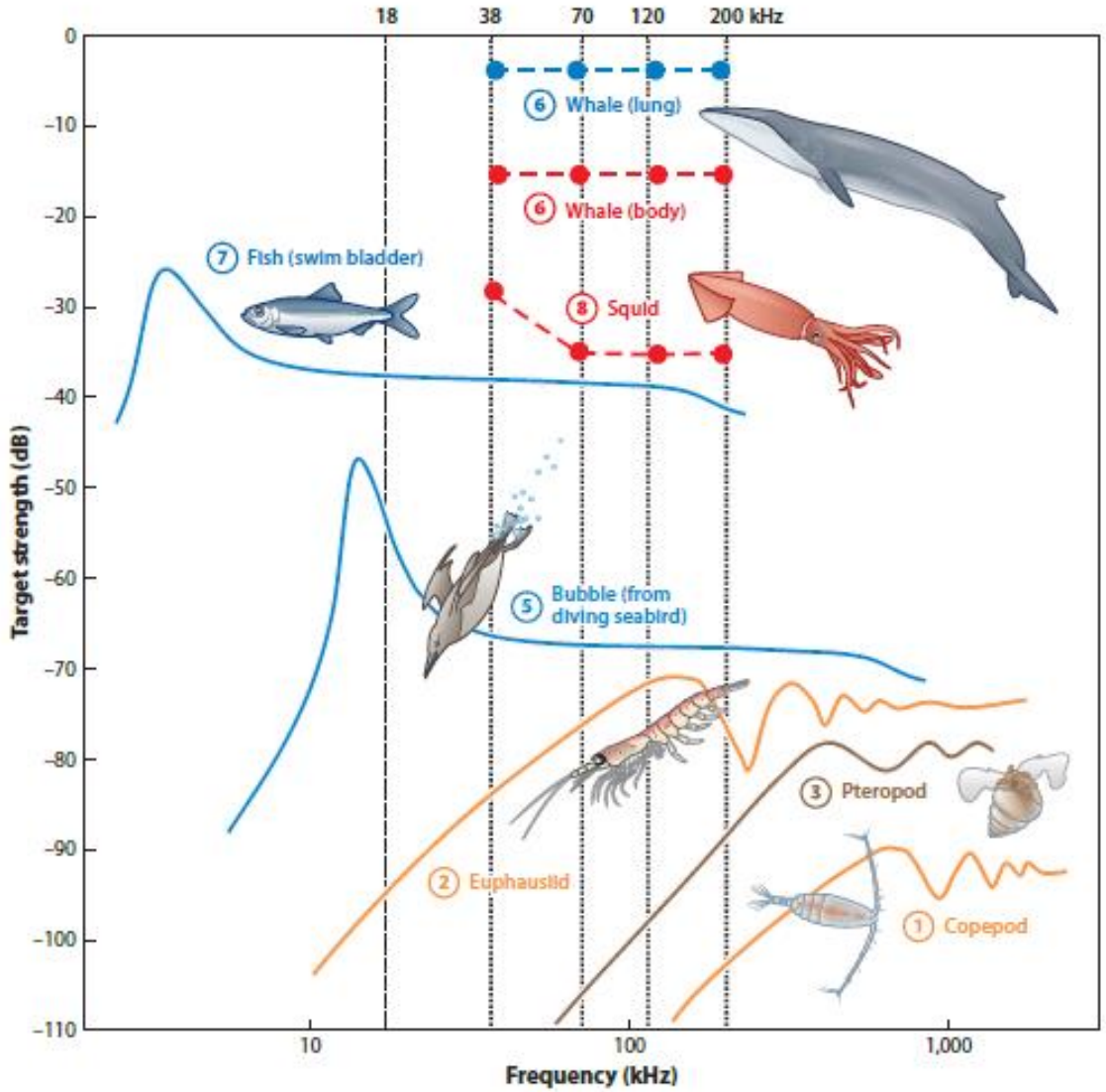


Day

Night

Acoustic density weakly stronger in the North tropical Atlantic ?

Frequency responses characteristic of different types of organisms



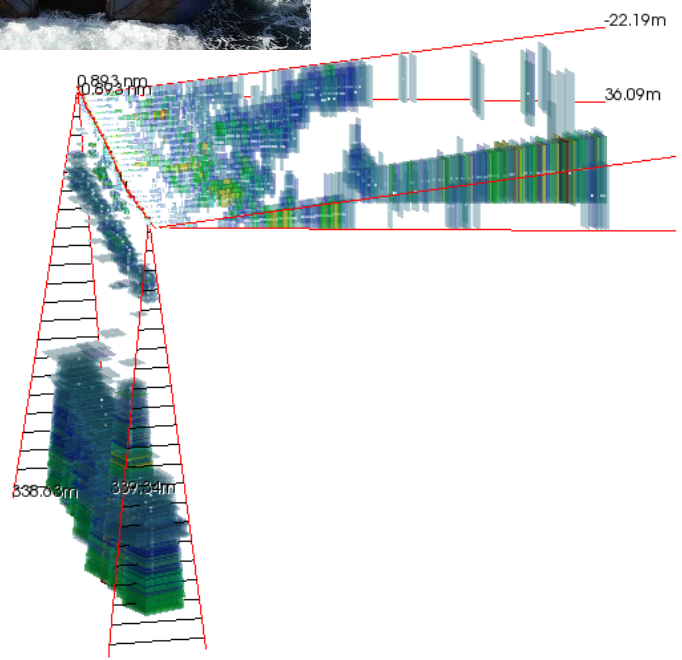
Benoit-Bird and Lawson 2016

À joindre aux perspectives!

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

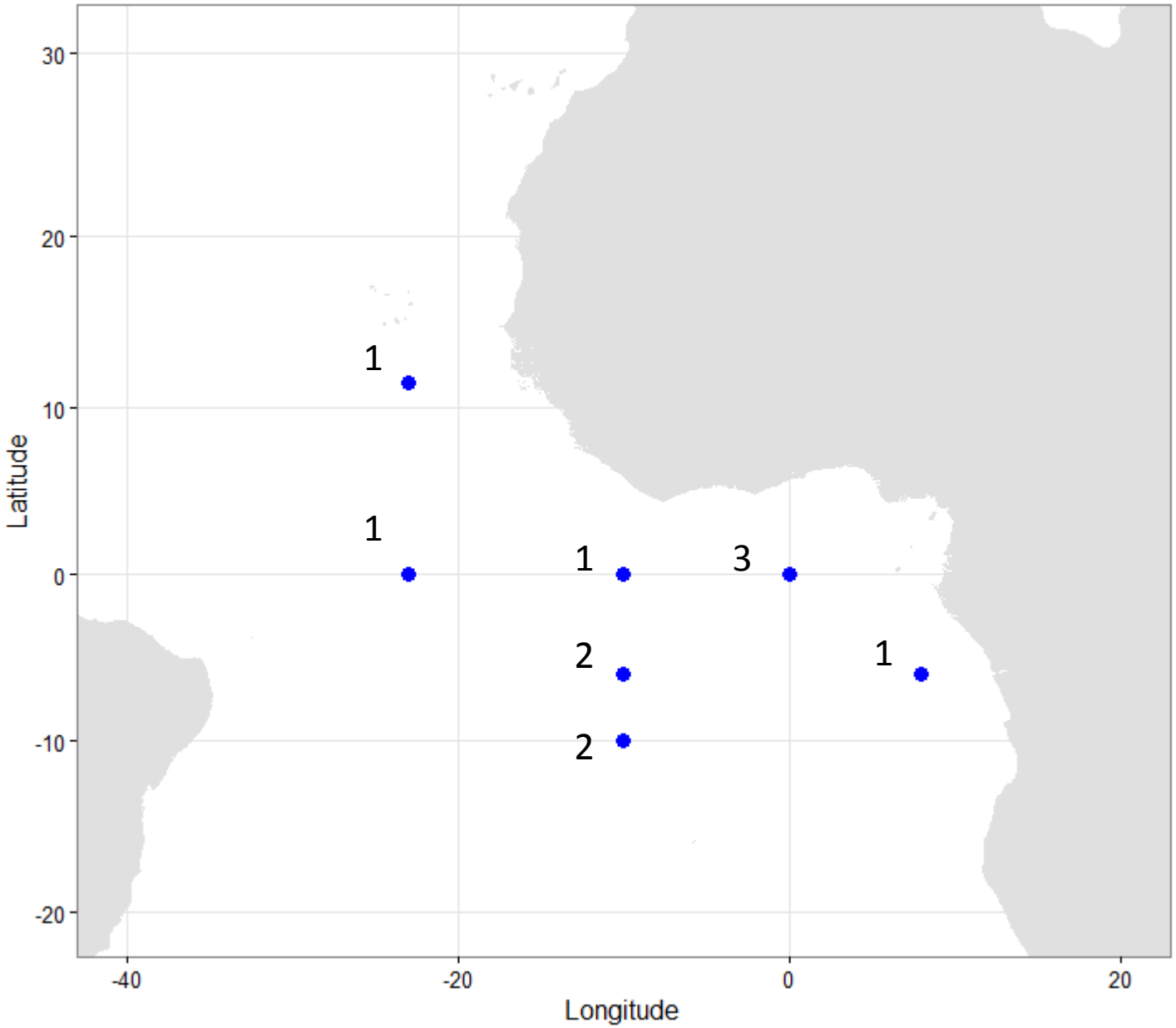
Acoustic data were echo-integrated onto 1 m layers over 0.1 nmi ESDU (elementary sampling distance unit)

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

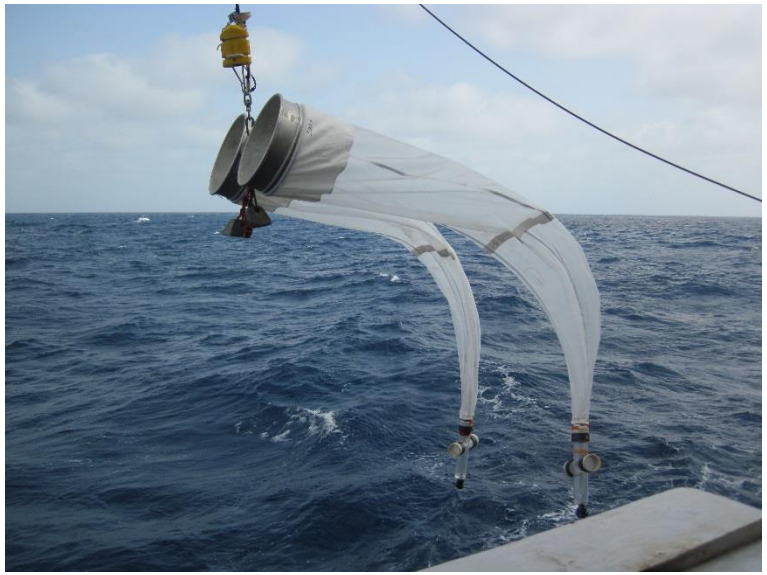
Threshold : -100 dB
Range : 20 m to 250 m.

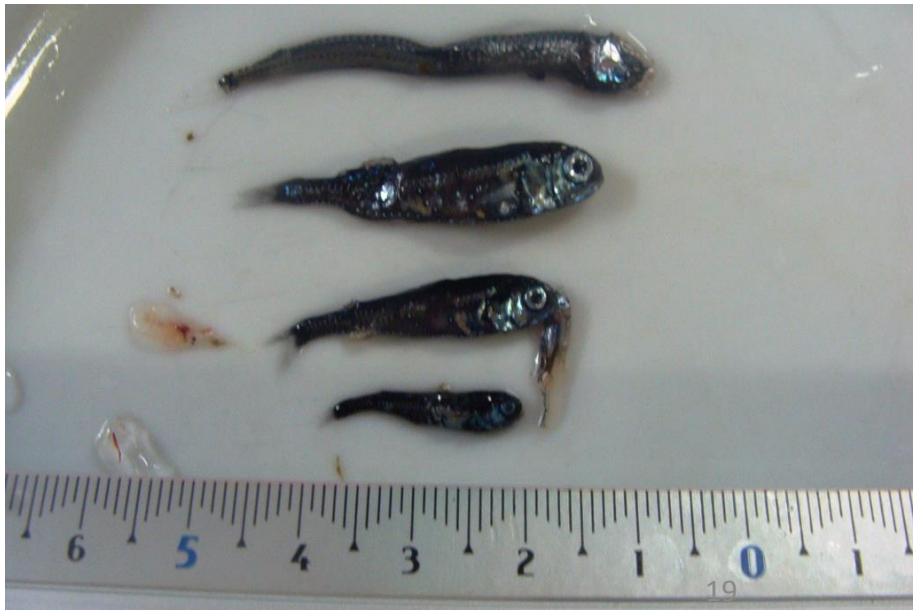
Net data

FR26 - Map of sampling locations



Bongo net (300 µm) from 200 m to the surface

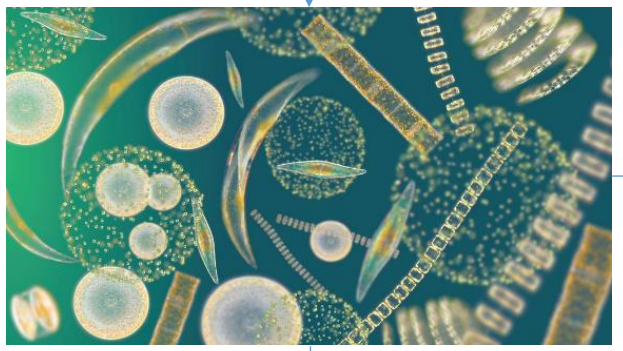




Trophic food web

Light, circulation, temperature, nutrients

Phytoplankton



Copepods

Euphausiids

Myctophiids

Amphipods

Cephalopods

Small fish

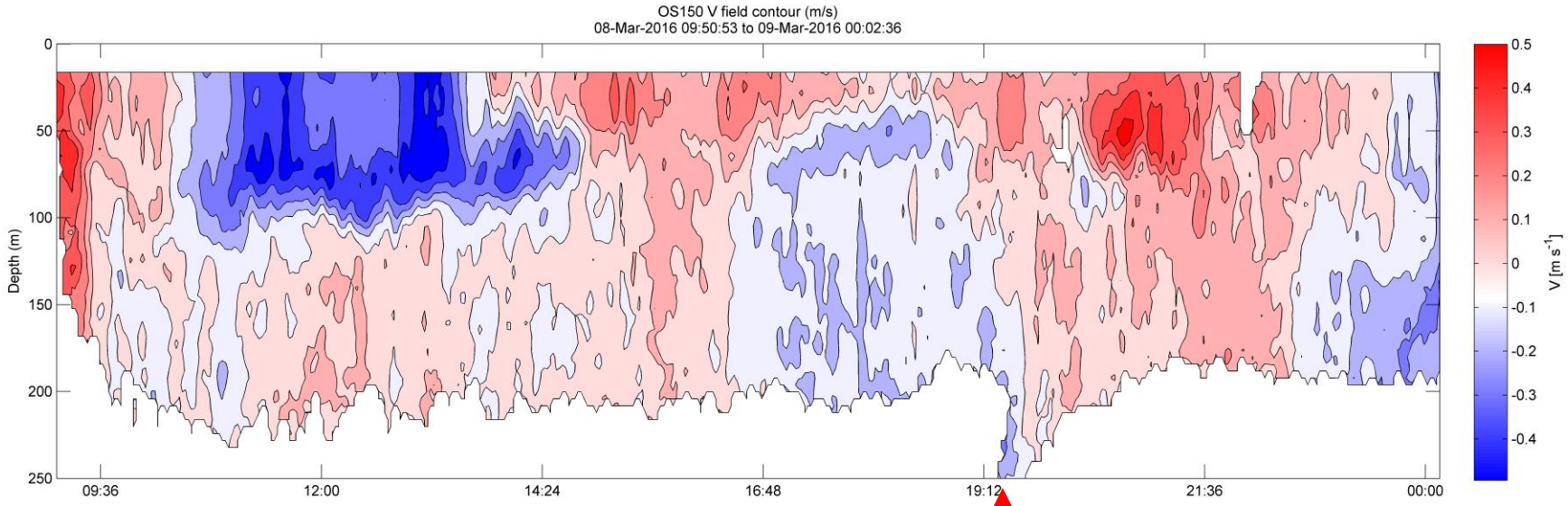
Tuna

Wahoo

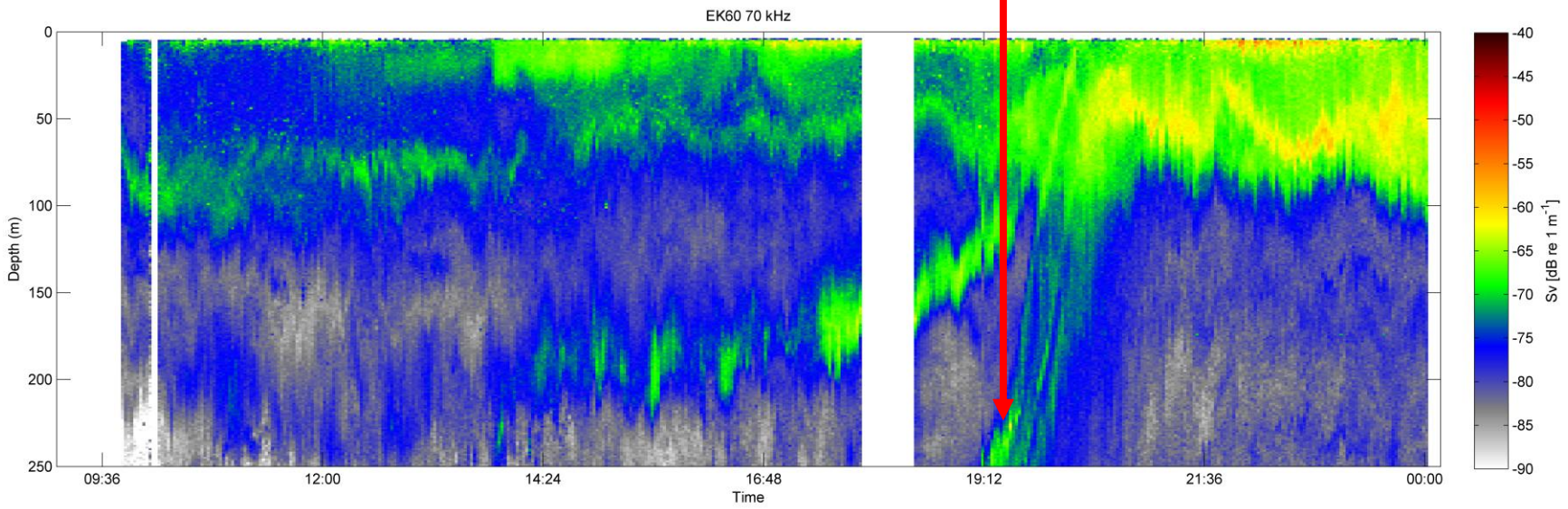
Sternoptyx

Mahi-mahi

Le courant structure t-il la distribution des communautés ?



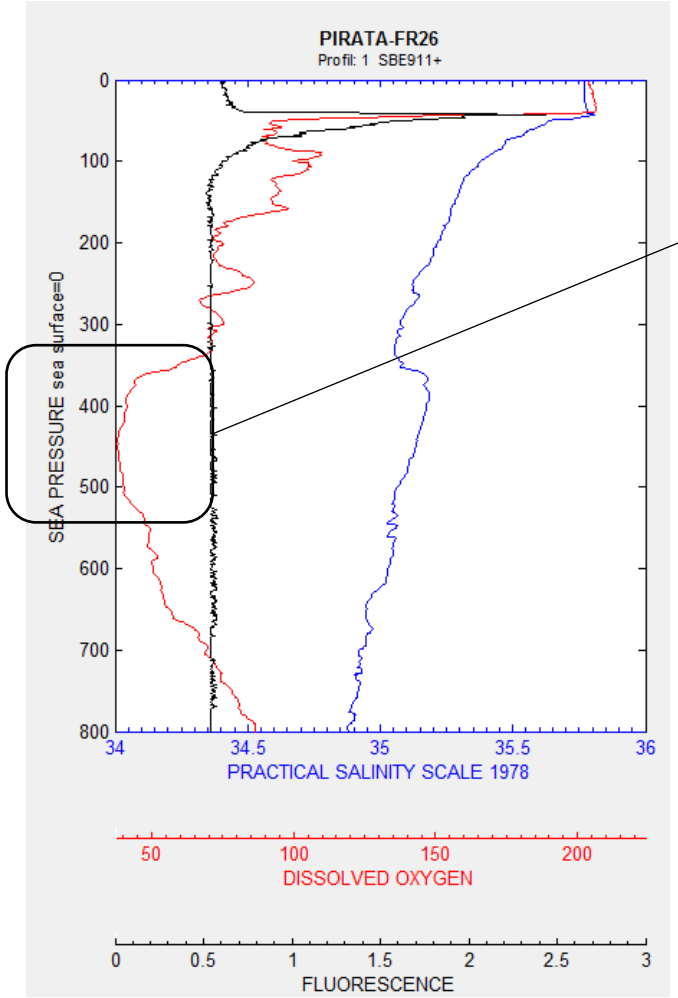
Migration nycthémérale visible sur les données ADCP OS150

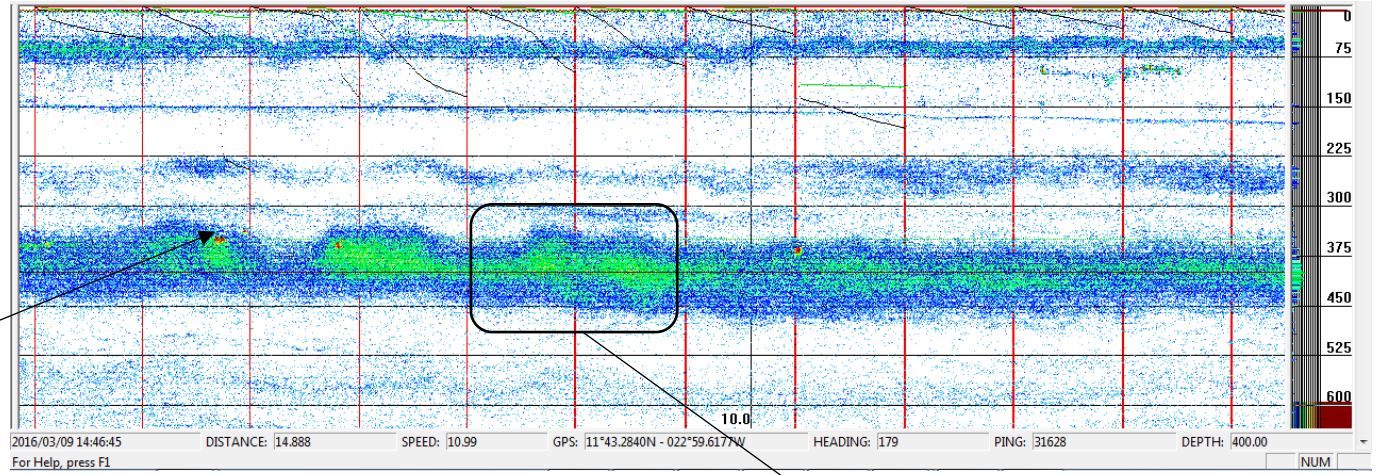


Voir avec Bernard/Gaëlle

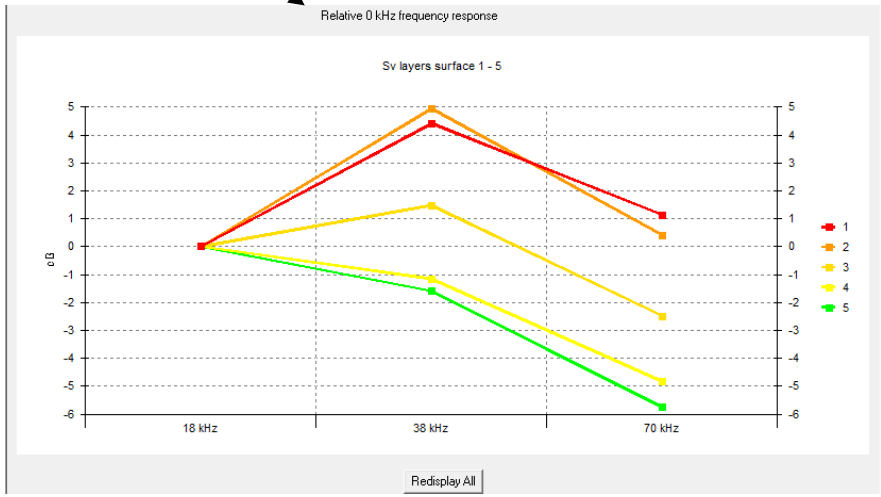
Vertical distribution patterns and hydrology

CTD station at 12°N-23°W





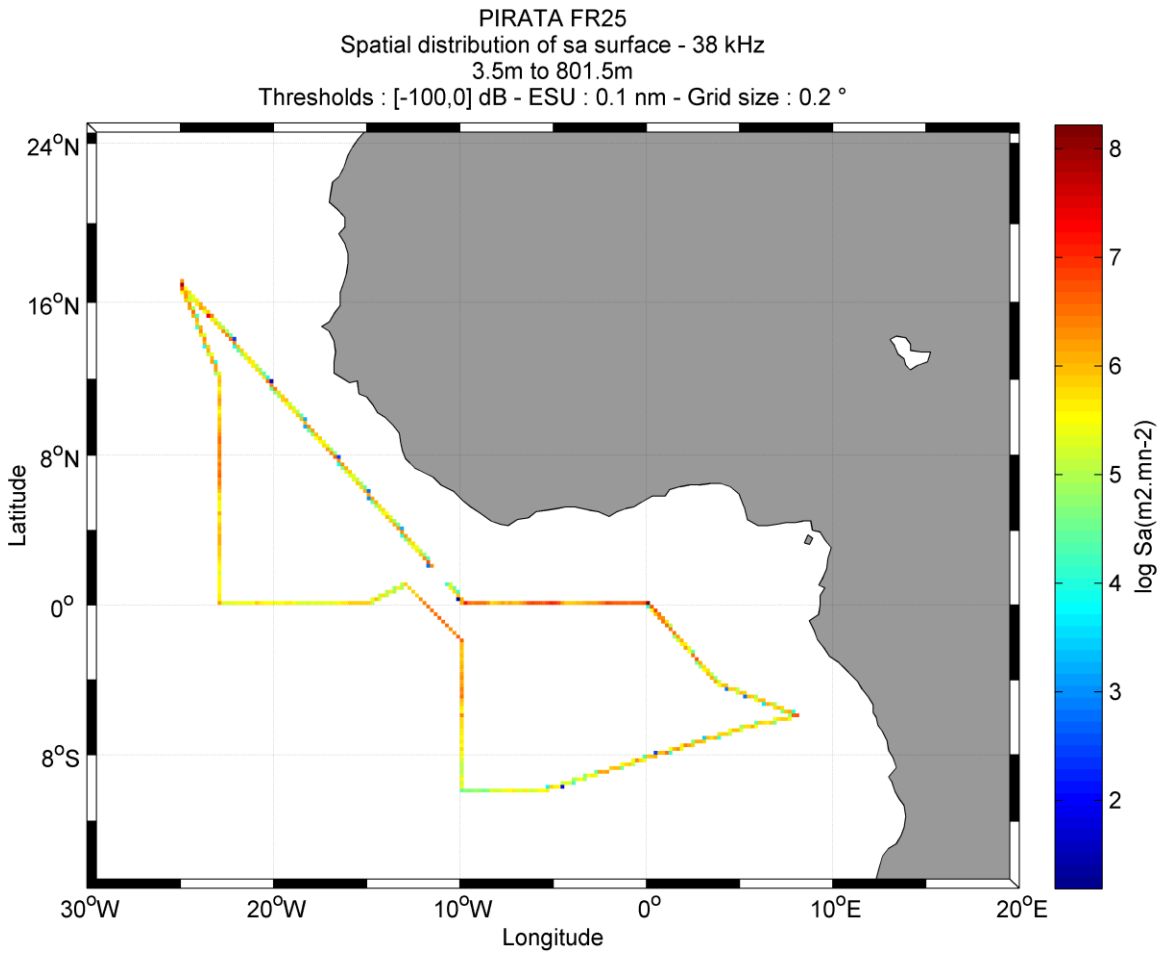
Relative frequency response curve

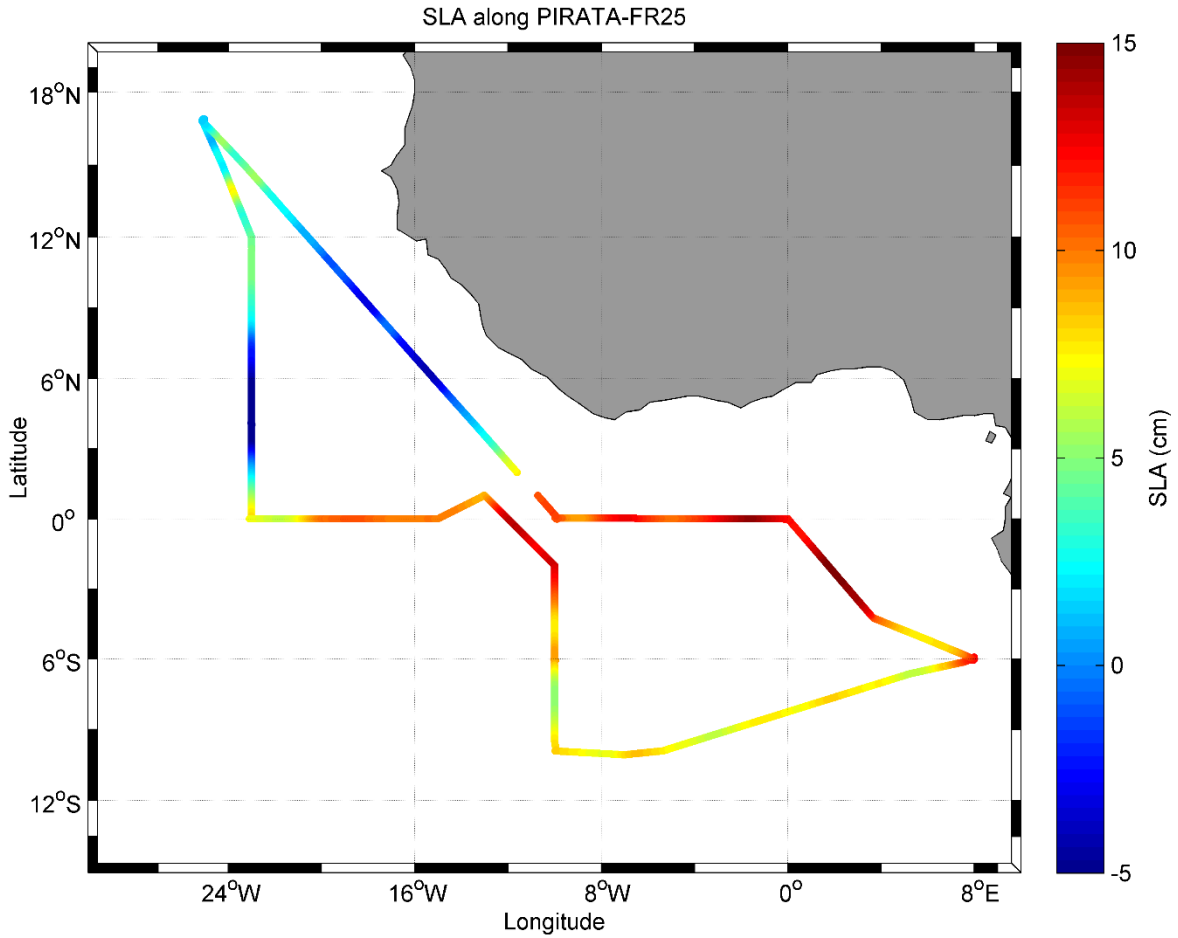


Different sizes of Myctophids ?

Ajouter échelle?

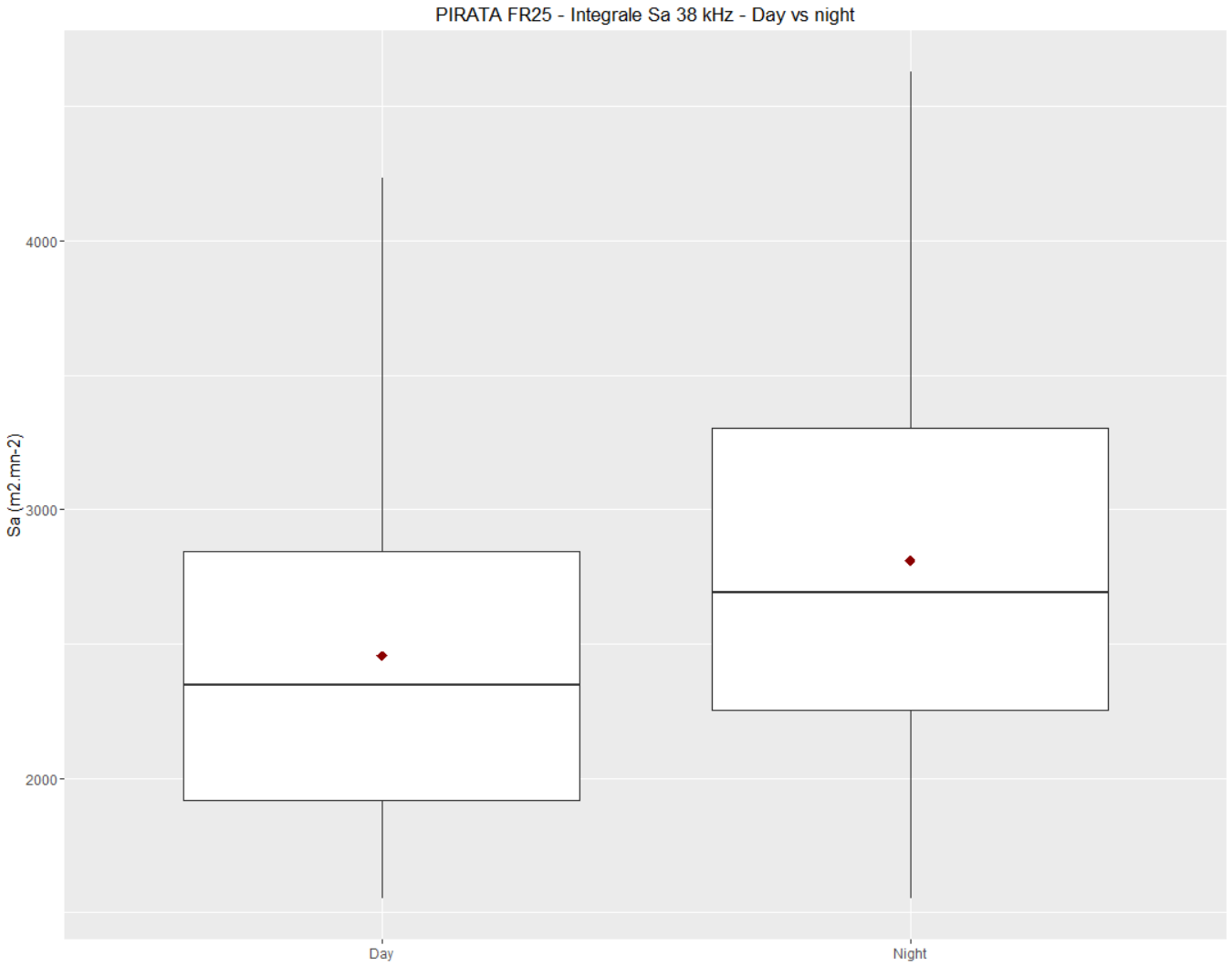
- **High Deep Scattering Layers (400-600m) densities at 38 kHz during daytime correspond to anticyclonic eddies ?**





Source: AVISO

Acoustic vertical profiles – Integrale Sa



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 ?