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

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Introduction

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

Zooplankton layer, identification with Bongo

Squids eat myctophids and krill

Mammals eat squids

Benoit-Bird & Lawson, 2016
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?
Characterization of water masses:
Thermosalinograph, CTD-O2, nutrients and pigments, SADCP

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

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

Example of a 24h registration

18 kHz

38 kHz

Surface scattering layer

Deep scattering layers

Vertical migration

Global mean acoustic vertical profiles

FR26: 38kHz

Light is a key driver

Night->Black / Sunrise->Yellow / Day->White / Sunset->Red
Sunset and sunrise defined for solar elevation angle between -18° and 18°
Vertical distribution and hydrology

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

Acoustic profile night
Acoustic profile day

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

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

- **2015**
  - Equatorial section
  - 0°N-10°W to Mindelo

- **2016**
  - Main CTD section
  - Congo river plume
Congo river plume impact

120 kHz lateral

18 kHz vertical

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

Colder SST and shallower thermocline in 2015
⇒ More nutrients
⇒ Higher acoustic density
Section 0°N-10°W to Mindelo

2015

Echogram at 38kHz

2016

Latitude

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.
Location: 8°S
Time resolution: 2 min

SADCP 38 kHz - Meridional velocity

EK60 18 kHz
Vertical acoustic density patterns

Vertical distribution patterns

North to 2°N

South to 2°S

Acoustic density weakly stronger in the North tropical Atlantic?

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

<table>
<thead>
<tr>
<th>Frequency (kHz)</th>
<th>Range (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>1000</td>
</tr>
<tr>
<td>38</td>
<td>800</td>
</tr>
<tr>
<td>70</td>
<td>400</td>
</tr>
<tr>
<td>120</td>
<td>250</td>
</tr>
<tr>
<td>200</td>
<td>120</td>
</tr>
<tr>
<td>333</td>
<td>80</td>
</tr>
</tbody>
</table>

Lateral (FR26 only)

<table>
<thead>
<tr>
<th>Frequency (kHz)</th>
<th>Range (meters)</th>
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<tbody>
<tr>
<td>120</td>
<td>250</td>
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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.
FR26 - Map of sampling locations

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

Phytoplankton → Copepods → Euphausiids → Myctophiids → Amphipods → Sternoptyx
Phytoplankton

Light, circulation, temperature, nutrients

Copepods

Euphausiids

Myctophiids

Amphipods

Sternoptyx

Cephalopods

Tuna

Small fish

Wahoo

Mahi-mahi
Migration nyctémérale visible sur les données ADCP OS150

Le courant structure-t-il la distribution des communautés ?

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
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 ?