Planktonic and Micronektonic Scattering Layer distribution along latitudinal section: from North Est Atlantic to Eastern Tropical Pacific Oceans

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INTRODUCTION

Sound Scattering Layers (SSL), created by aggregations of micronekton and large zooplankton, are ubiquitous in oceans worldwide. These layers are vital components of marine ecosystems, serving as crucial links in the food web and actively contributing to the carbon cycle through their **Diel Vertical Migration (DVM)** behavior.

We focus on the North Atlantic Gyre, influenced by ocean currents like the Canary current and North Equatorial Current, which significantly shape the distribution and habitat conditions for these organisms. Analysis of SSL distribution patterns were performed along a trans-Atlantic sea survey (SO287 CONNECT), starting from the nutrient-rich Eastern Boundary Upwelling System (EBUS) off North West Africa and extending into the Eastern Tropical Pacific Ocean (Fig.1). We examines how these layers respond to key environmental factors, shedding light on their dynamic role in pelagic ecosystems.

METHODS

1. Data collection

- ✓EK80 Acoustic data (38 kHz)
- ✓ACDP data (75 kHz)
- ✓CTD data (temp., sal., O_2, Chl)

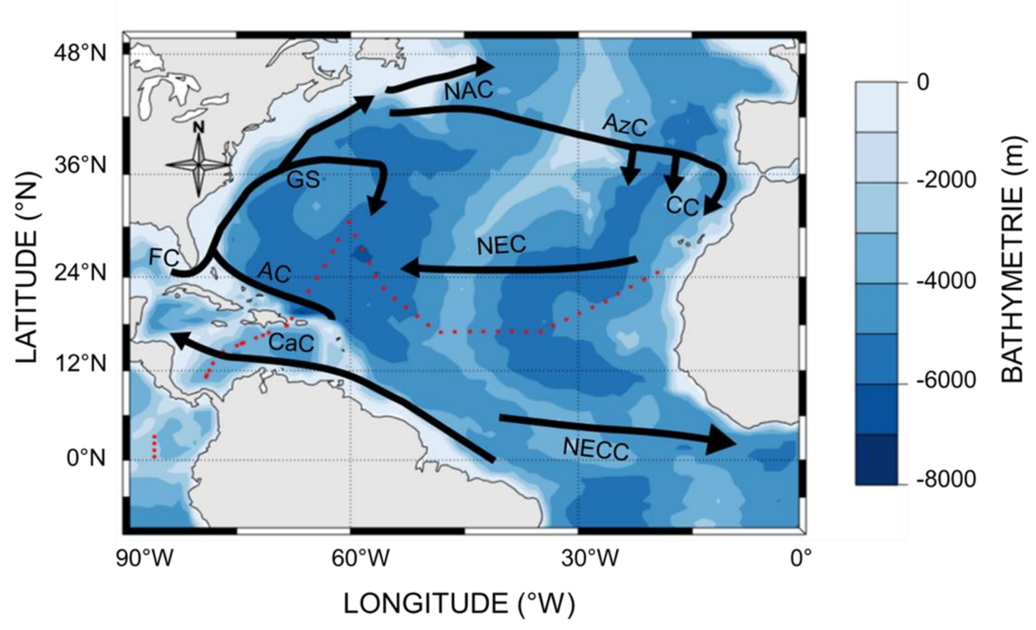

Fig.1: Location of the survey area

2. Acoustic Data Processing

- ✓ Echogram correction, echointegration
- ✓ SSLs extraction (threshold: -75 dB)
- ✓ SSLs descriptors computing (Fig.2)

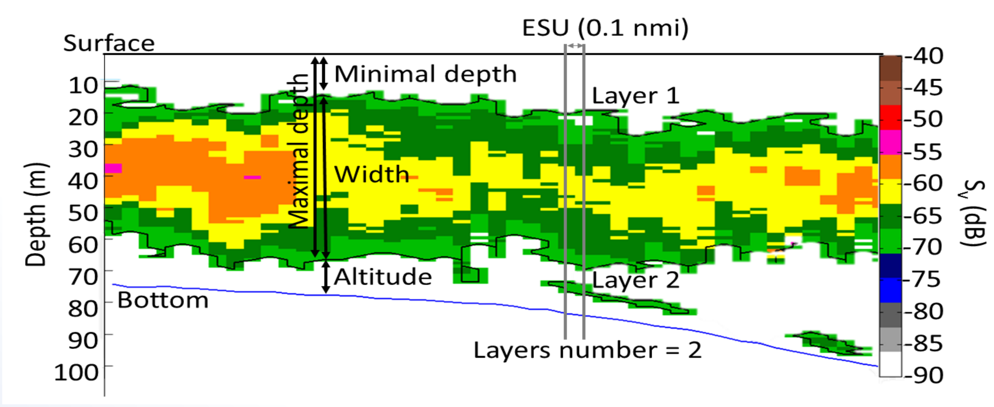

Fig.2: Schema showing typical sound scattering layers (SSLs) descriptors: Maximum depth, minimum depth, width, of SSL,

3. Statistical analysis

K-means clustering & GAMMs : SSLs descriptors *vs.* environment

DISCUSSION & CONCLUSION

Regional variations in SSLs with Atlantic and Pacific regions were reported, showing thicker SSLs, possibly indicating higher biomass. The Pacific's shallow SSLs are linked to high relative biomass and the Oxygen Minimum Zone (OMZ). In the Sargasso Sea, a single deep SSL is reported, despite low productivity, while the Caribbean's comparable characteristics, coupled with higher relative biomass, emphasize environmental influences. Consistency in SSL structure across regions, alongside diverse DVM patterns, underscores the intricate dynamics of SSLs.

RESULTS

SSLs acoustic characterization

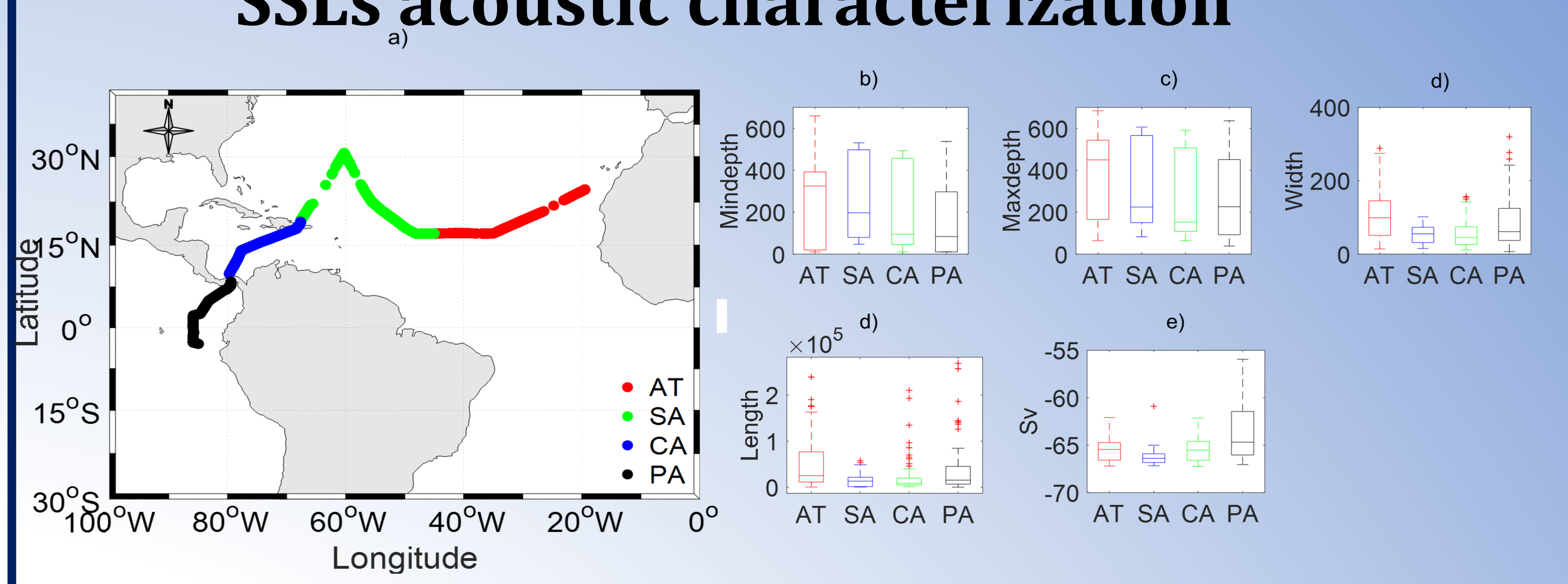

Fig.3: K-means clustering results for 38 kHz echosounder data. (a) Four identified clusters: AT (Eastern Tropical North Atlantic Ocean), SA (Sargasso Sea), CA (Caribbean Sea), and PA (Eastern Tropical Pacific Ocean). Boxplots (b-f) : including minimal depth, maximal depth, width, length, and Acoustic backscattering strength (Sv) of SSLs.

SSLs Vertical distribution

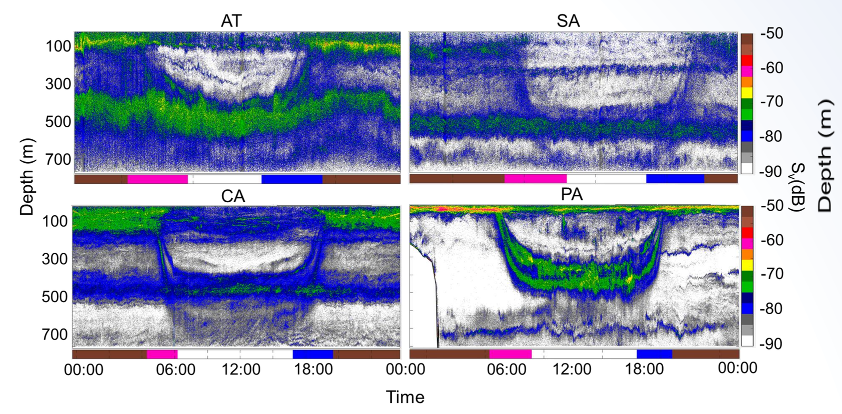

Fig. 4: Echograms (38 kHz, echosounder) spanning 24 hour periods and showing diel vertical migration across the surveyed area.

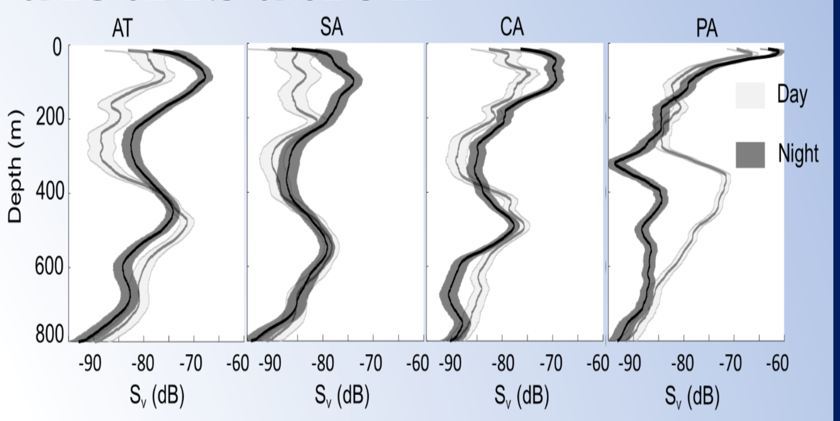

Fig. 5: Diel difference on the mean acoustic volume backscattering strength (S_v in dB) within the water column.

Environmental conditions in the surveyed area

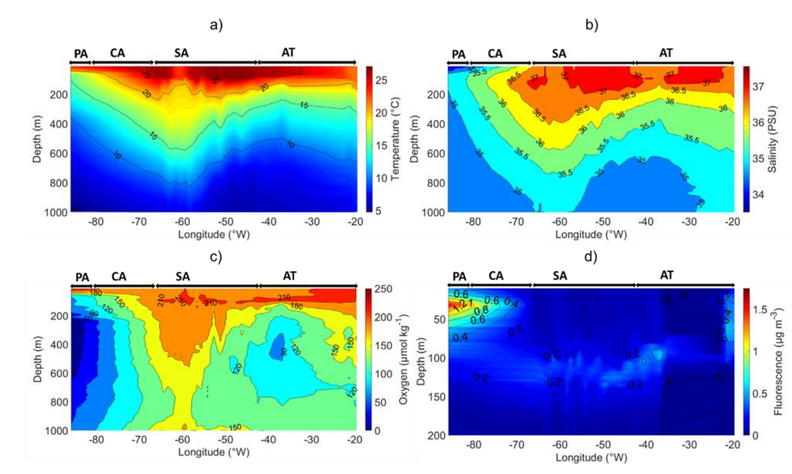

Fig.6: Contour plots of (a) temperature, (b) salinity, (c) dissolved oxygen, and (d) fluorescence in the entire surveyed area.

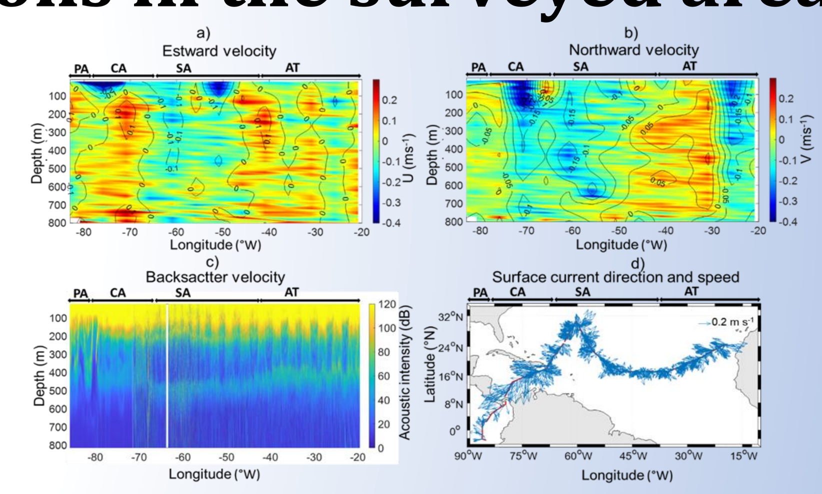

Fig. 7: Distribution of (a) eastward velocity, (b) northward velocity, (c) backscatter velocity, and (d) surface (< 200m) current direction and speed.

Environmental conditions *vs* SSLs distribution

Table 1: Result of GAM models between Weighted Mean Depth (WMD) and mean acoustic volume backscattering strength S_v (in dB) of sound-scattering layers (SSLs) and environmental parameters (sea temperature, salinity, dissolved oxygen, fluorescence, and diel period). Significant values (*p*-value ≤ 0.05 marked * , *p*-value ≤ 0.01 marked ** , *p*-value ≤ 0.001 marked ***.

Variables	Significance		Explained deviance (%)		Total deviance (%)	
	WMD	S_v	WMD	S_v	WMD	S_v
Area	0.019*	0.083	9.1	10.4	98.4	85.2
Diel period	0.005**	0.007**	1.1	1.7		
Temperature	2e-16***	8.38e-06***	40.4	23.5		
Salinity	2e-16***	0.004***	6.0	10.3		
Oxygen	2.77e-05*	0.000***	12.7	6.4		
Fluorescence	0.010*	0.001**	15.6	11.0		

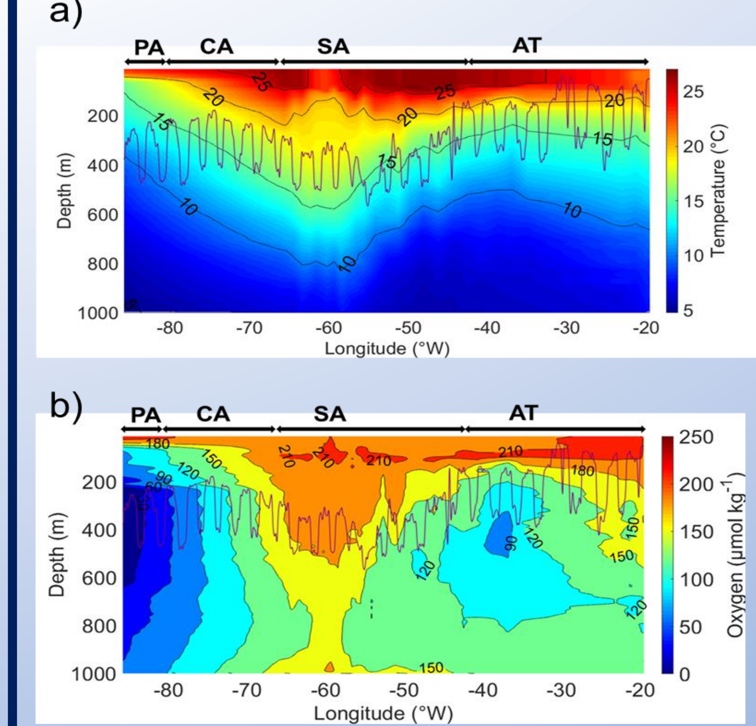

Fig.8: Vertical section from CTD probe for (a) sea water temperature, and (b) dissolved oxygen SA. Purple line depict the Weighted Mean Depth (WMD) on each panel.

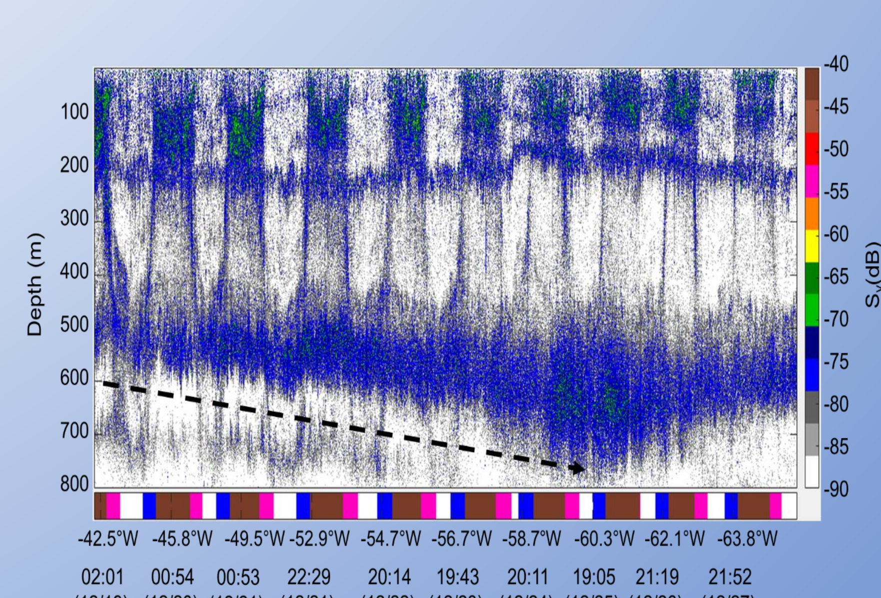

Fig. 9: Echogram (38 kHz) in the Sargasso sea depicting the deepening of the mesopelagic layer from 19/12 to 26/12/2021.

Local light conditions play a crucial role in DVM patterns. OMZs were observed in both oceans, raising concerns about their expansion and potential impacts on marine ecosystems and global warming. Sea temperature, fluorescence and oxygen levels emerged as primary drivers of SSL variation, influencing marine life and biogeochemical cycles.

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