Interest of micronektonic descriptors to monitor and compare aquatic ecosystems: application to the three African Large Marine Ecosystems of the Atlantic Ocean

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CONTEXT

Hydroacoustic is today an integral part of the sampling procedures for fish stock assessment recommended by the Water Framework Directive and has been standardized by the European Committee for Standardization (CEN 2014. EN 1590, 2014). In Europe, hydroacoustic surveys in freshwaters are performed using different frequencies. Consequently, there is a need to evaluate if survey results can be compared. This study aimed to carry out in situ comparisons of the 38 kHz frequency with two other frequently used frequencies, 70 and 200 kHz.

METHODS

Micronektonic layers have been recorded at 38 kHz using hull mounted vessel echosounders in the three Atlantic African Large Marine Ecosystems (LME). We have used a dedicated data processing method under Matlab® named Matecho to extract echosounder data. To describe marine ecosystems, allowing inter-comparison and a better understanding of their functioning, we developed and/or adapted 12 descriptors that describe and characterize the micronektonic layers. All layer descriptors are estimated per layer and per elementary sampling unit of 0.1 nautical miles (ESU) with an accuracy of 1 meter depth. In this study we present four classes of descriptors: spatial (*e.g.* altitude, mean depth, minimal depth); morphological (*e.g.* width, ESU number, filling rate of water column); acoustic (*e.g.* mean volume backscattering strength S_v (dB)) and the layer number per ESU. Some of them are particularly innovative as the water column filling rate. We tested relevance of all these descriptors to monitor and compare LMEs.

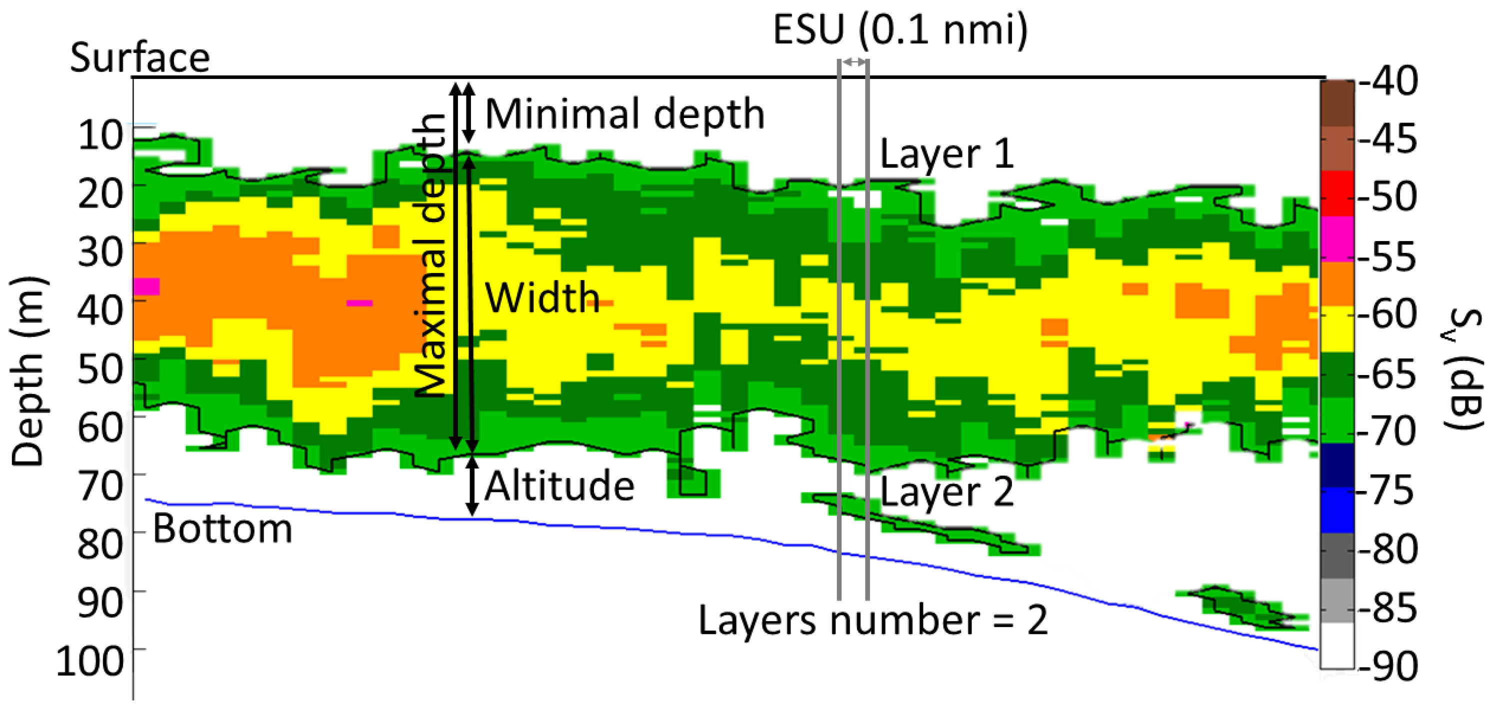

Fig.1: Presentation of some layers descriptors exported by Matecho: Maximal depth, minimal depth, width, altitude and layers numbers. On right, coloured Sv (dB) panel. On left, depth (m). Layers have been extracted and are contoured by black line. Bottom is represented by the blue line. An example of Elementary Sampling Unit (ESU) is contouring by grey lines.

RESULTS

SPATIAL: INTRA-LME COMPARISON

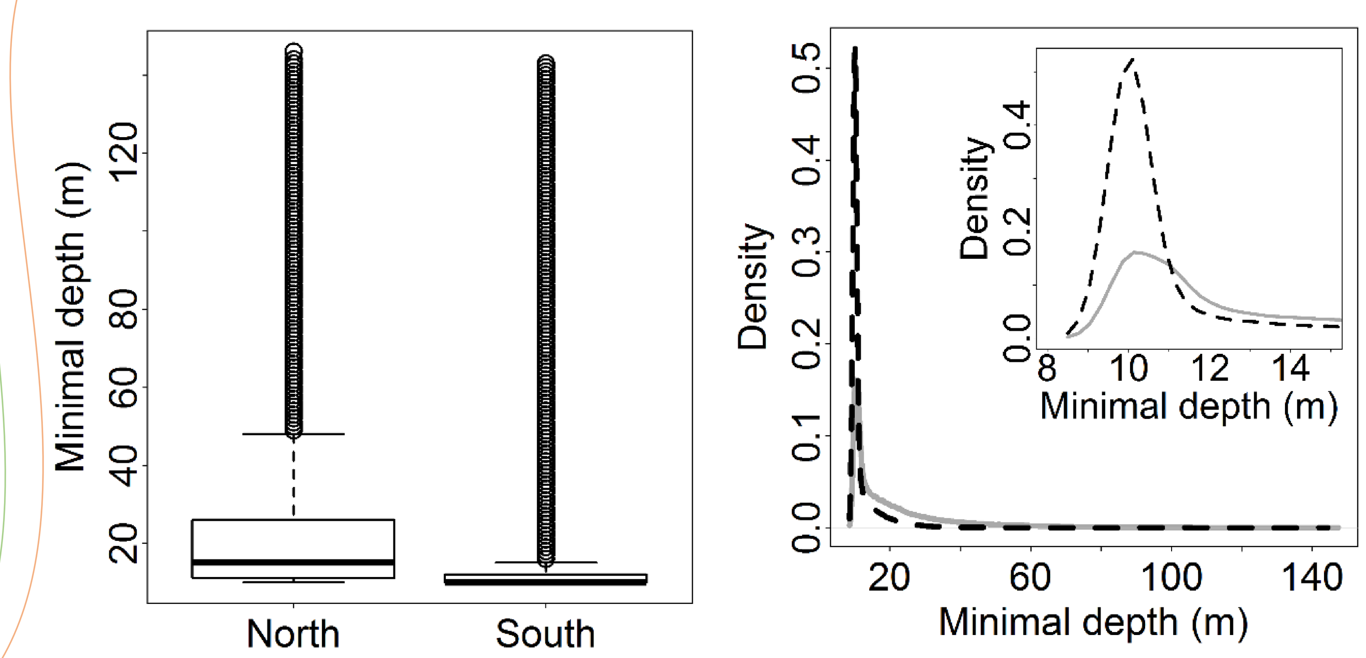

Fig.2: Boxplots (a) and density curves (b) of minimal depth in CCLME Ecosystem North (plain grey) and South (dotted black). On the top left of the density curve is a zoom of this density curve between minimal depth from 8 and 15 m.

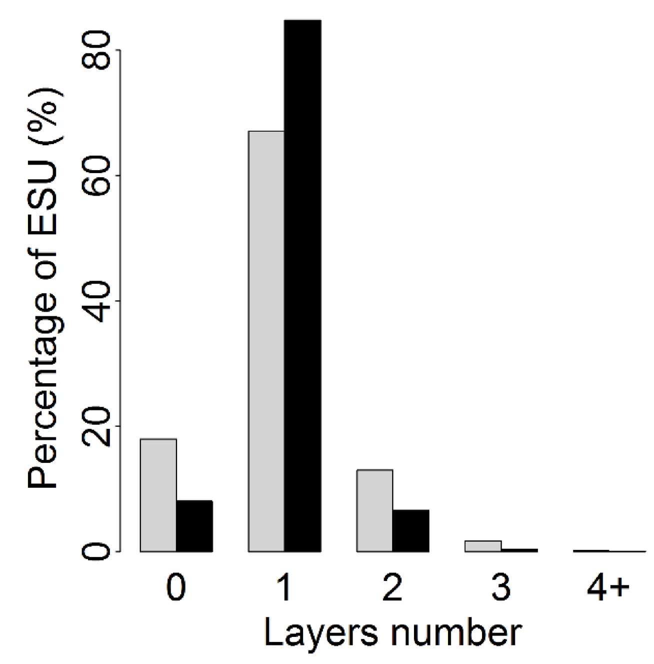

Fig.3: Barplots of layers number in CCLME North (grey) and South (black).

TEMPORAL: DIEL COMPARISON

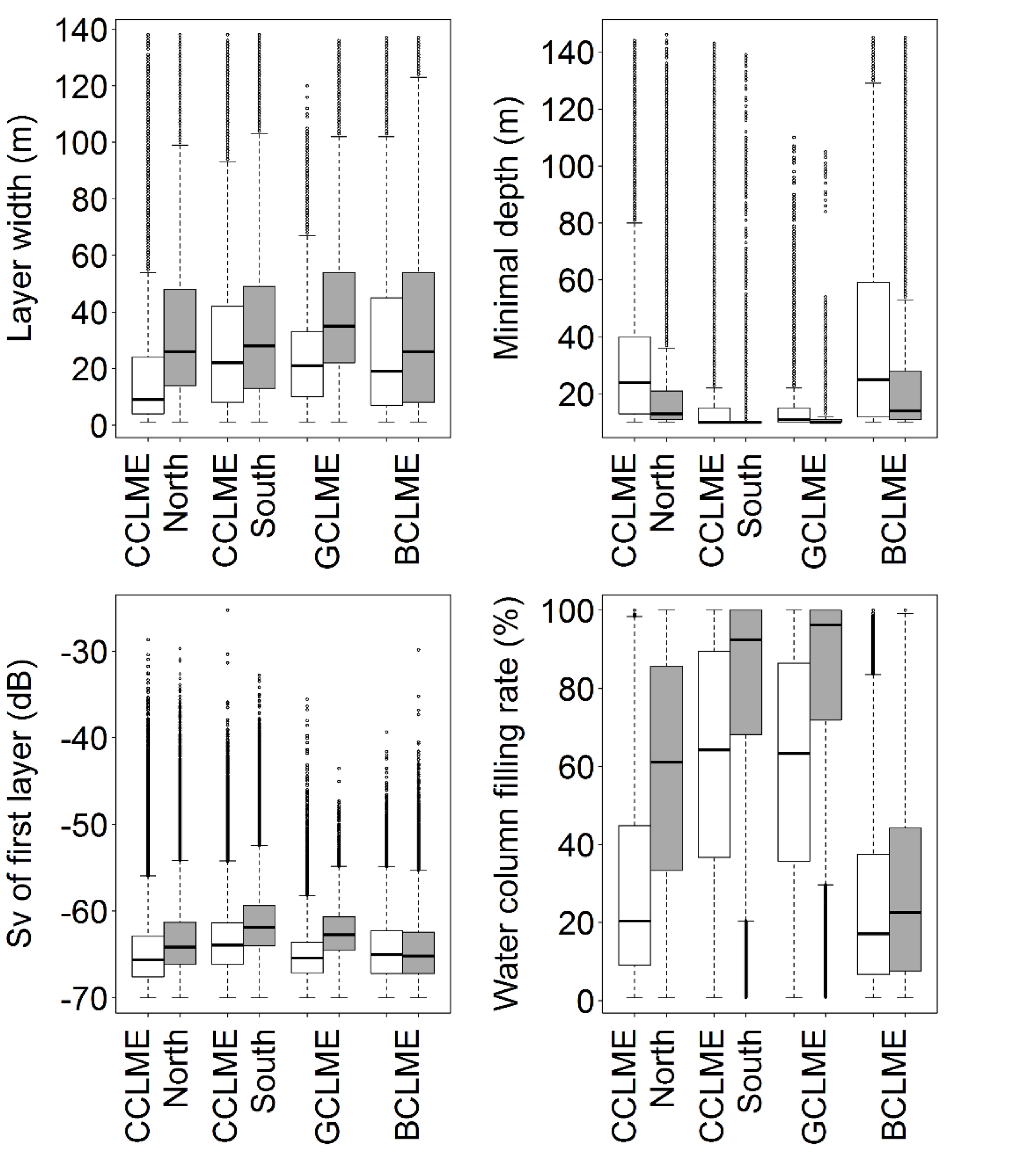

Fig.5: Boxplot of minimal depth during (a), width of first layer (b), S_v of first layer (c) and water column filing rate of first layer (d) during day (white) and night (grey) for CCLME North and South, GCLME and BCLME (from left to right for each comparison).

TEMPORAL: INTER-ANNUAL COMPARISON

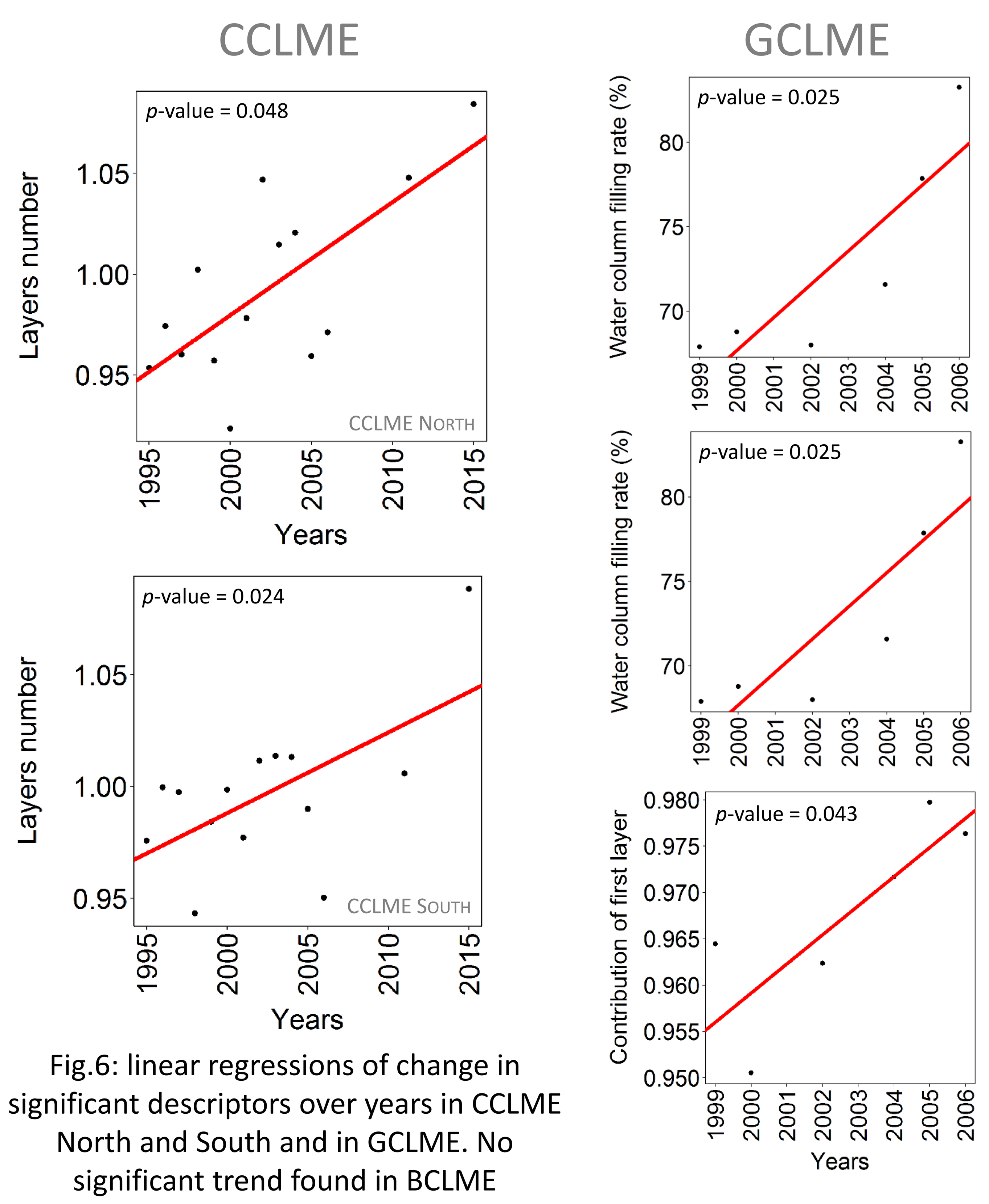

Fig.6: linear regressions of change in significant descriptors over years in CCLME North and South and in GCLME. No significant trend found in BCLME

SPATIAL: INTER-LME COMPARISON

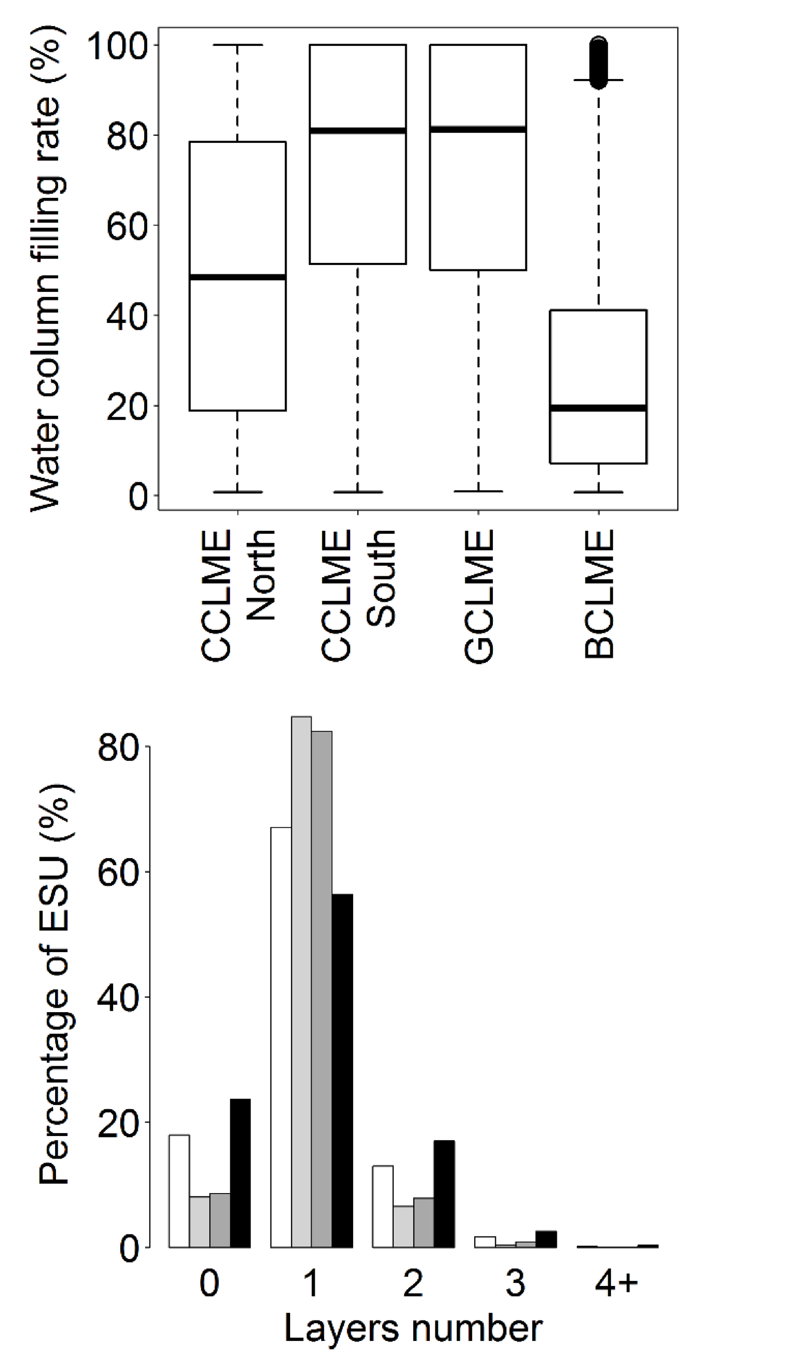

Fig.4: Boxplots of water column filling rate and barplots of layers number in CCLME North (white) and South (light grey), GCLME (dark grey) and BCLME (black).

DISCUSSION

The spatial dimension is scrutinized by intra- and inter-LME comparisons. The intra-LME comparison was tested on the CCLME North and South. The micronektonic layers descriptors are efficient to highlight this difference. Inter-LME comparison was tested on the two CCLME parts, GCLME and BCLME. Results also highlight the effectiveness of these descriptors to compare ecosystems. Then the characterization of the temporal dimension is studied at two levels: on diel and annual variations in each LME. Diel variations are particularly well discriminated using our layer descriptors as well as inter-annual changes which are highlighted by some descriptors in CCLME and GCLME but not in BCLME. As perspective we propose to marine managers and associated organisations to better consider the micronektonic layers descriptors in their dashboard as they appear able to monitor and compare marine ecosystems and thus capture potential change.