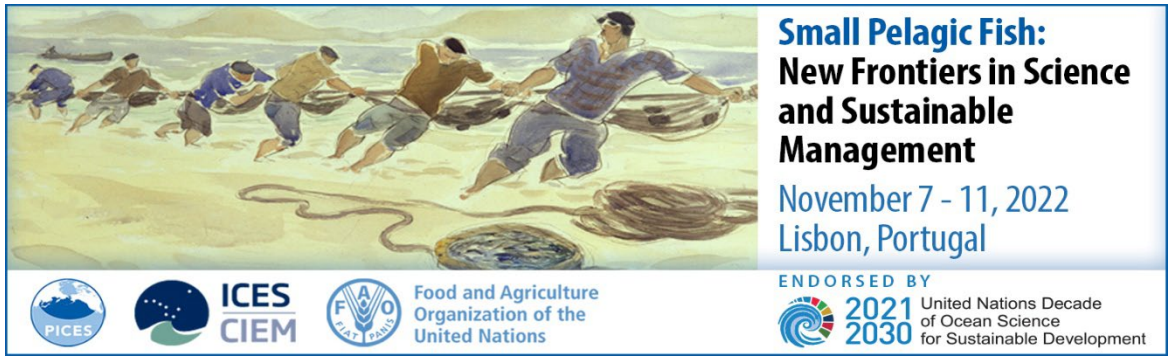
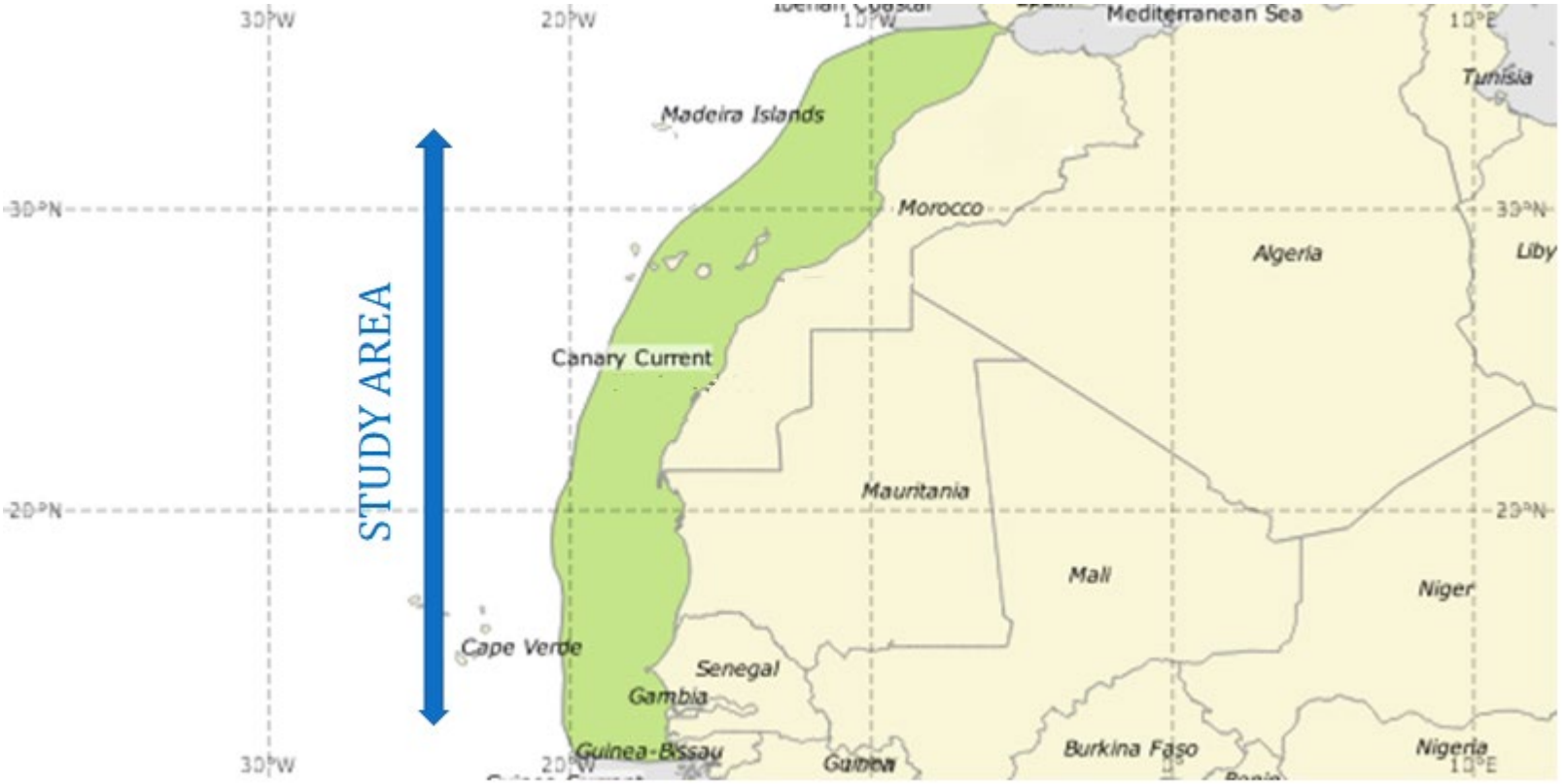


On the robustness of an eastern boundary upwelling ecosystem exposed to multiple stressors

Ndague DIOGOUL

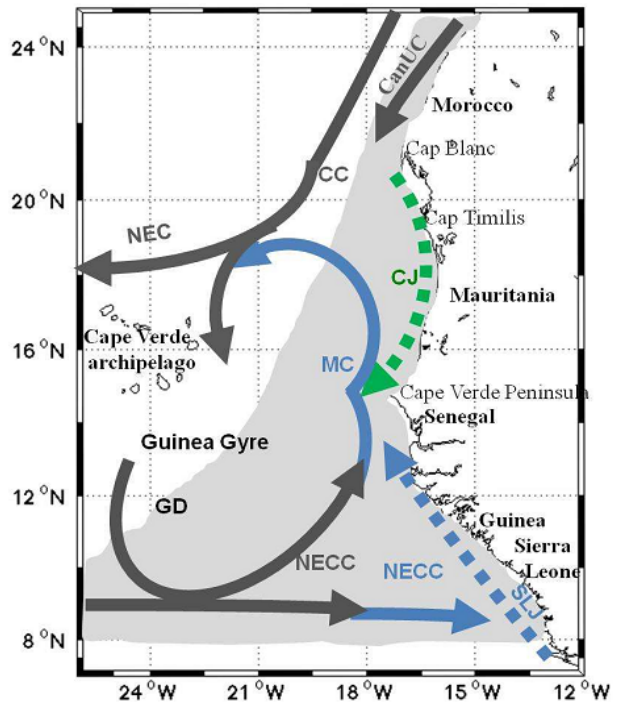
The Canary Current Large Marine Ecosystem (CCLME) : the largest eastern boundary upwelling ecosystem (EBUE)



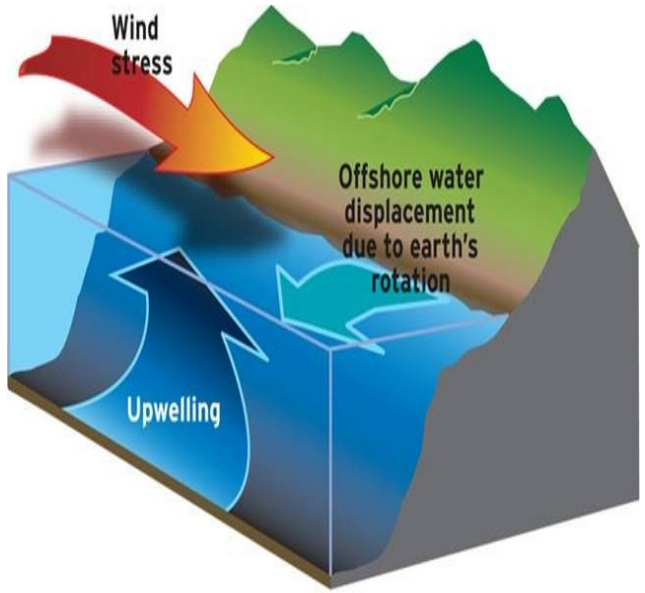
CCLME : One of the most productive ecosystems in the world.

Permanent

Seasonal



Currents



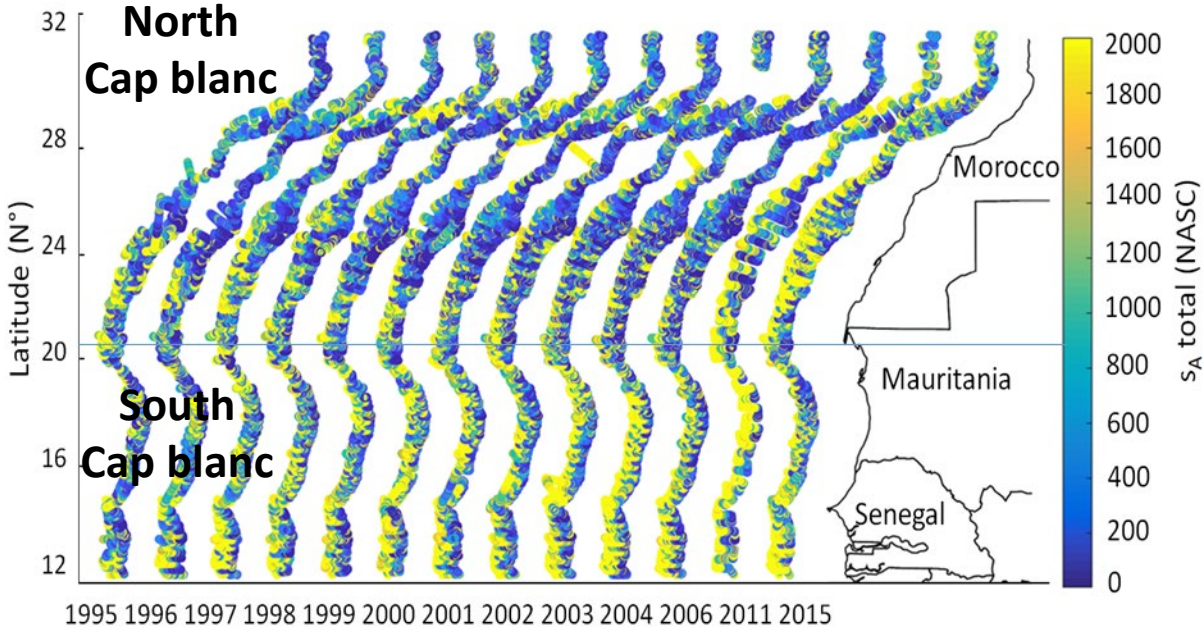
Upwelling

- Marine organisms are sensitive to environmental changes.
- Changes in the abundance and distribution limits of a number of species in relation to environmental changes have been highlighted.

Goals: ➡ Analyze long-term trends of relative marine pelagic abundance in relation to environmental factors in the CCLME.

Acoustic data

- Hydroacoustic surveys from 1995 to 2004, 2006, 2011 & 2015;
- EK500 and EK60 sounder at 38 kHz;
- The relative acoustic density, expressed as NASC or S_A. was used as a proxy of marine organism abundance.



CCLME continental shelf with total density (NASC, m^2 nmi^{-2}) from 1995 to 2015

Environmental data collection (satellites)

- Upwelling Wind (UW) from 1988 to 2017

  CCMP product version V2.0

- Sea Surface Chlorophyll concentration (SSC)

  SeaWIFS (1997-2002) and AQUA-MODIS (2003-2018)

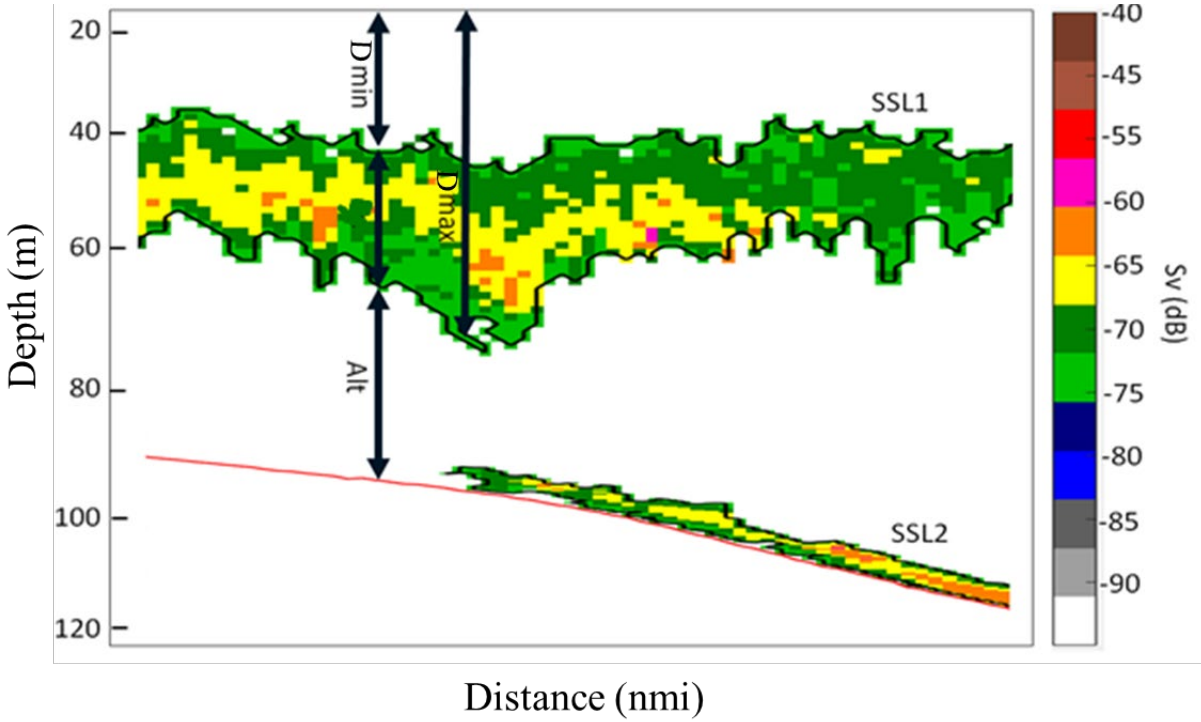
- Sea Surface Temperature (SST) from 1982 to 2018

  Pathfinder AVHRR version 5.2

Acoustic data treatment using « Matecho »

- Echo-integration 0.1 nmi * 1 m
- Layer extraction (-70dB)
- Calculation of layer descriptors for each ESU

  (number, thickness, Pmin, Pmax, S_A, S_v)



Scheme showing layer descriptors

Acoustic data analysis

A “thresholding” approach used to separate marine organisms into two acoustic classes:

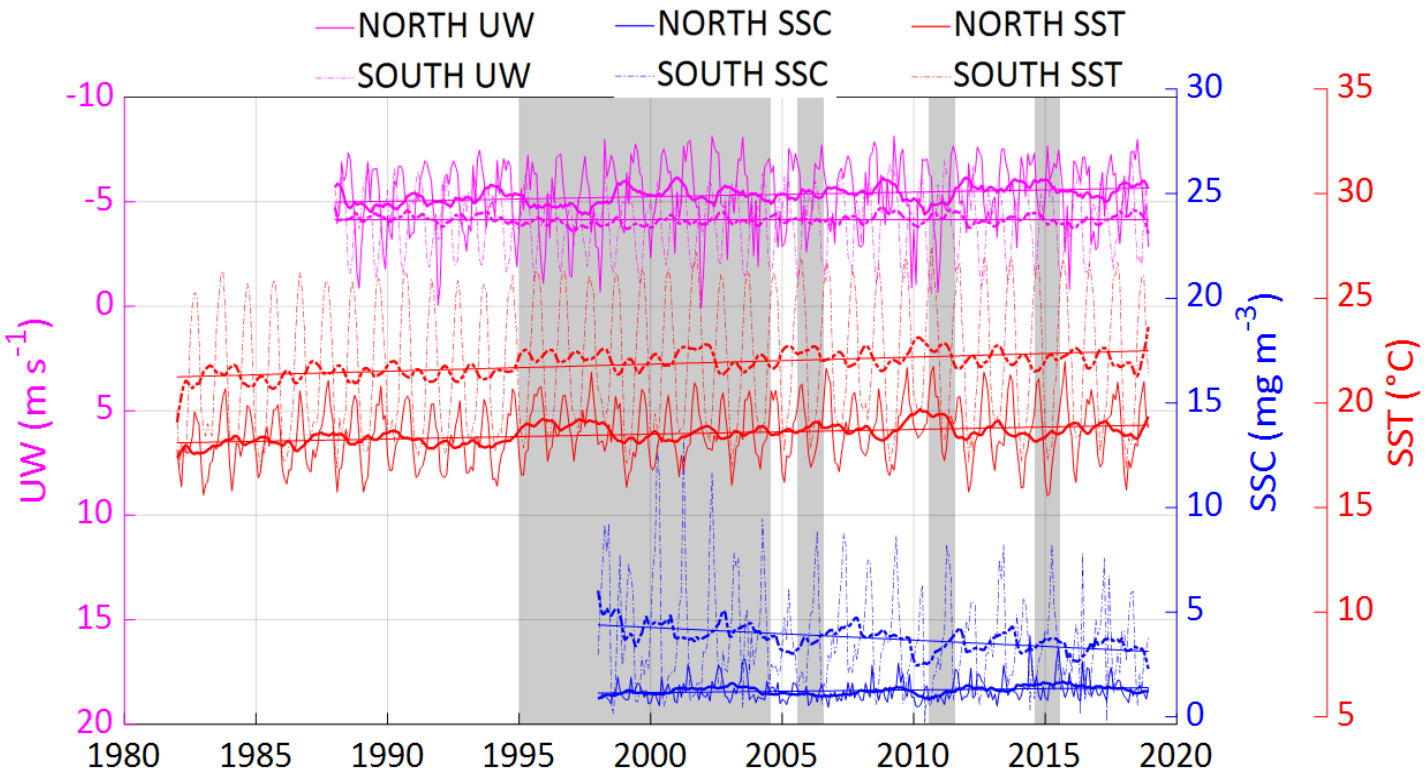
$[-80 \leq S_v < -65\ dB]$ → Low acoustic trophic level
i.e. Plankton Group (PG)

$[-65 \leq S_v < -20\ dB]$ → High acoustic trophic level
i.e. Pelagic Fish Group (PFG)

S_v : Volume backscattering strength

Environmental trend in the CCLME

Annual mean of SST, SSC, UW, North (plain line) and South (dotted line) of Cape Blanc (CB).

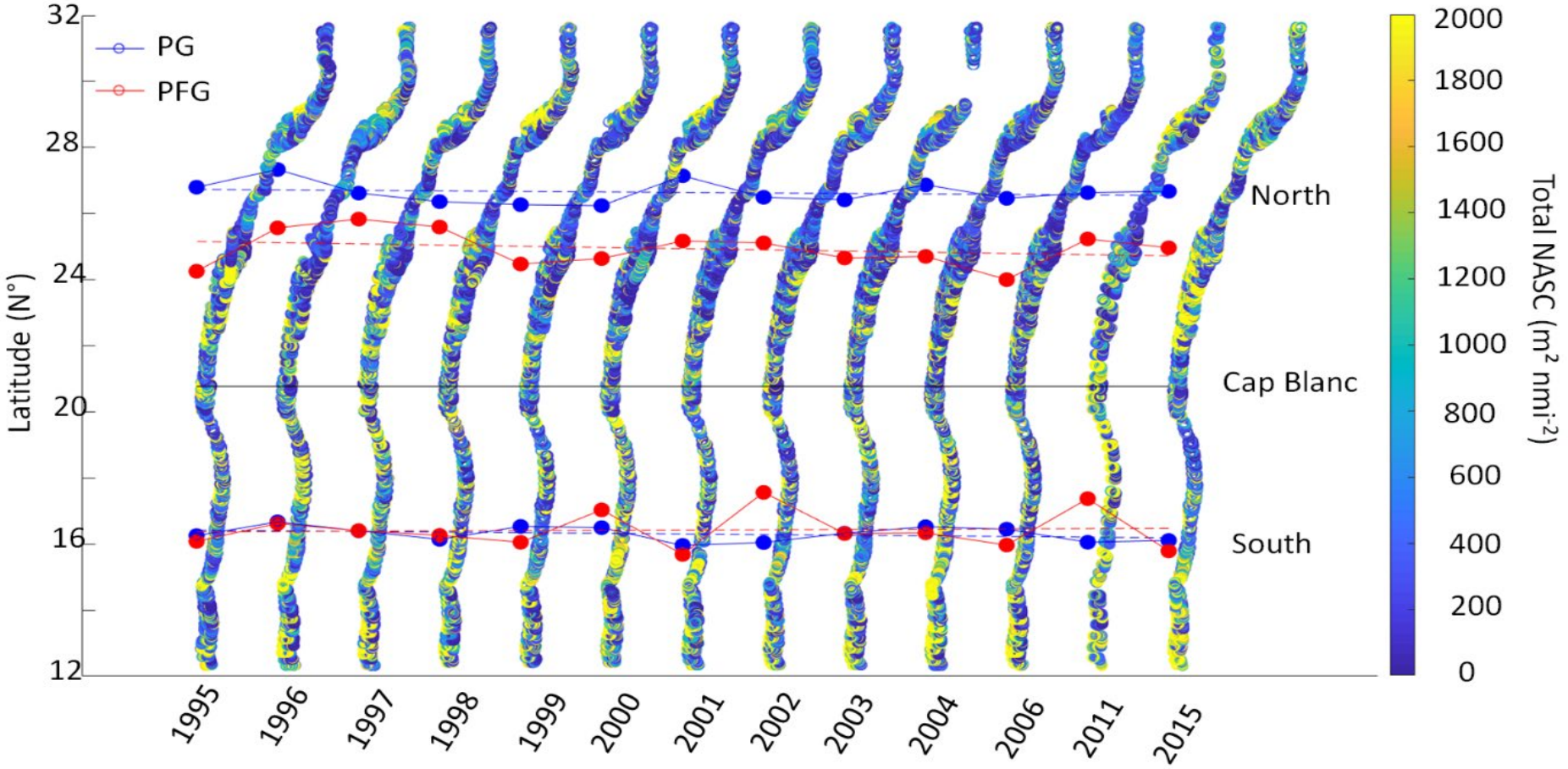


Test of environmental trends in North and South Cap Blanc. r : Spearman correlation coefficient.

	North Cap Blanc		South Cap Blanc	
Variable	r	p-value	r	p-value
SST	0.5	**0.000**	0.6	**0.000**
UW	0.4	**0.028**	0.06	0.90
SSC	0.4	**0.024**	-0.6	**0.000**

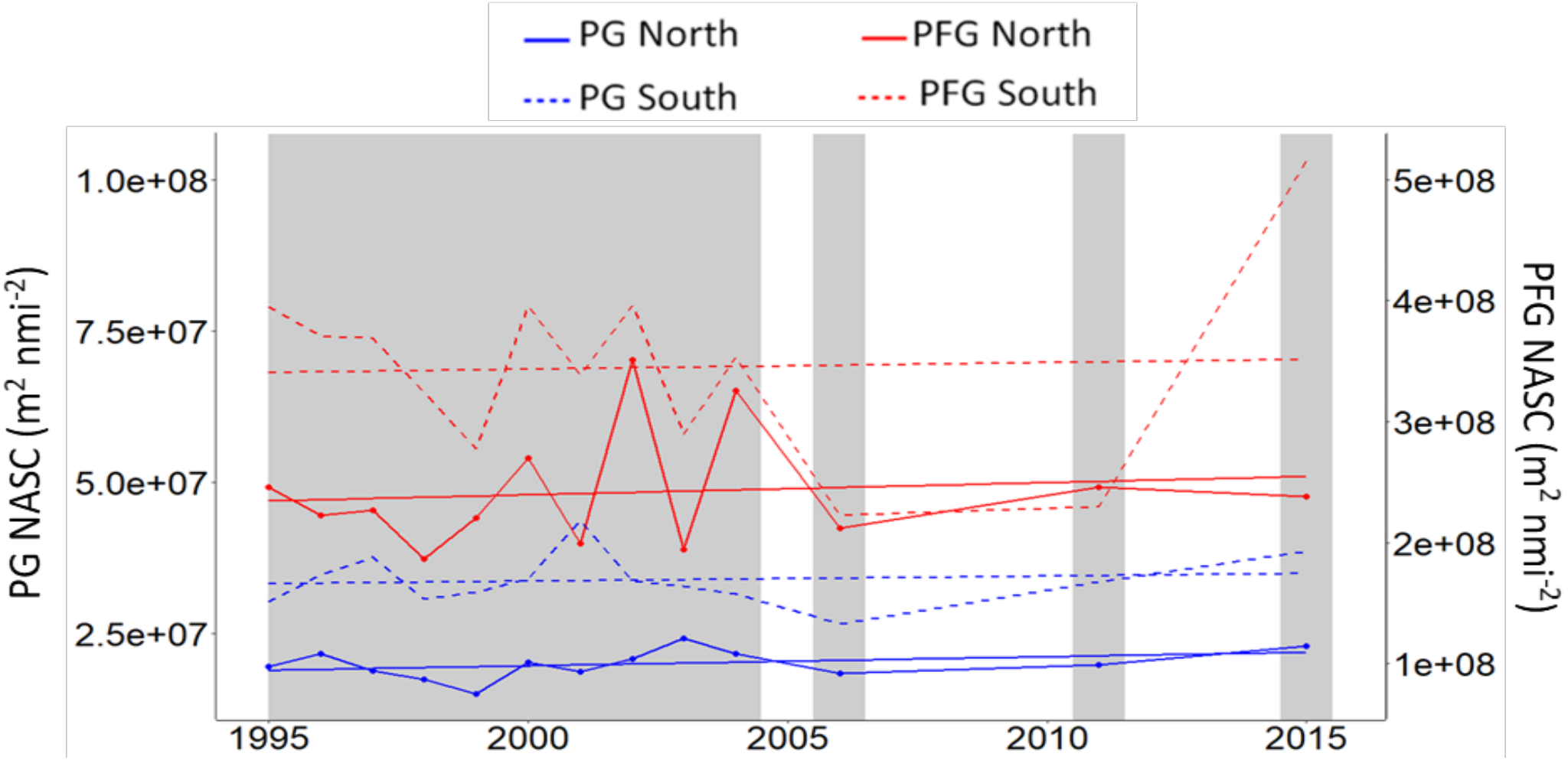
Barycenter displacement analysis

Barycenter of the two trophic levels studied: plankton group (PG), blue dots, and pelagic fish group (PFG), red dots. Dashed lines represent the linear trends for each group.



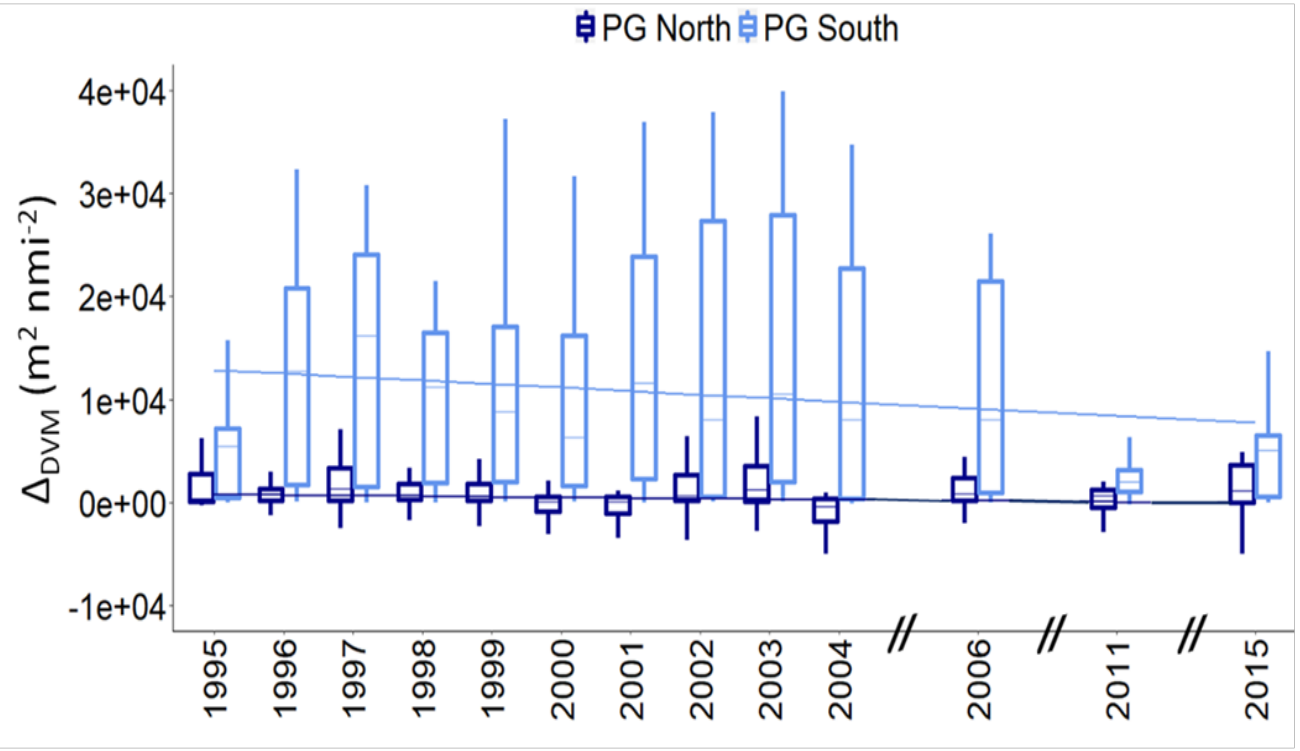
Trends in acoustic density in the CCLME

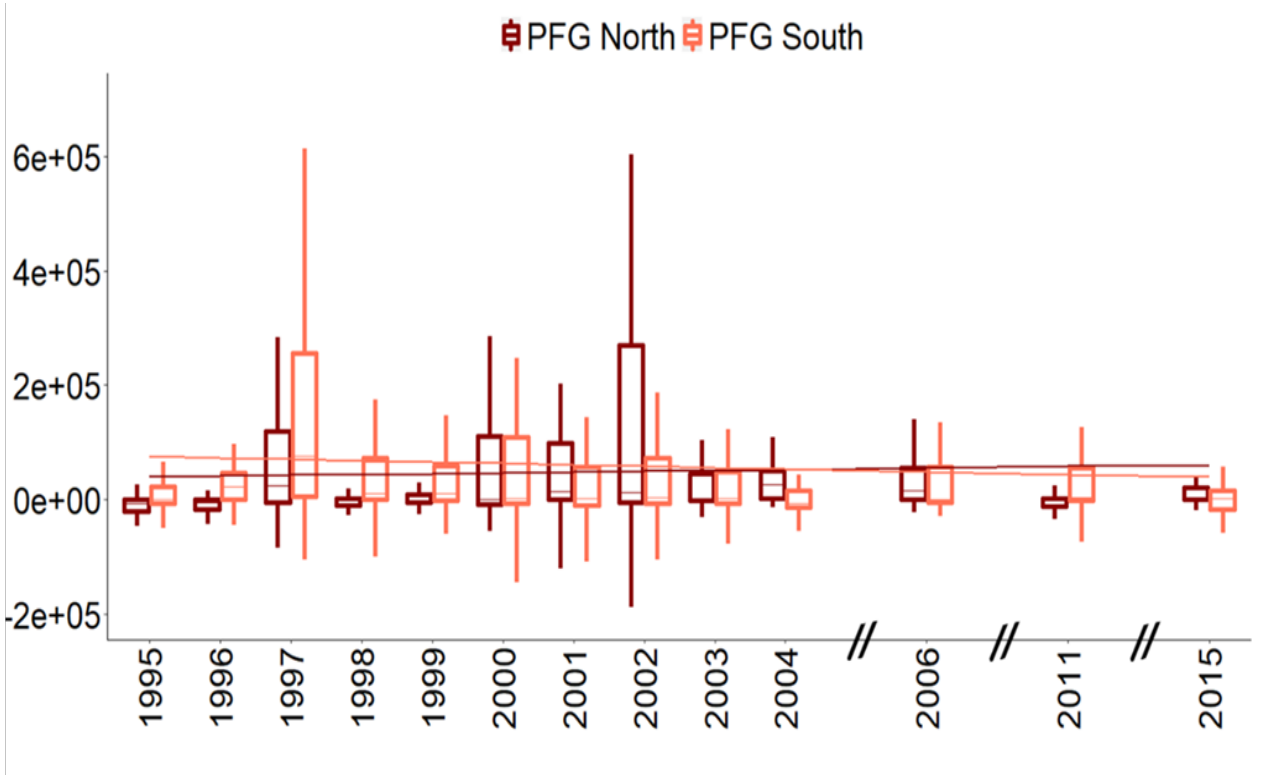
Variation of the mean Nautical Area Scattering Coefficient (NASC, m^2 nmi^{-2}) in North and South of Cap Blanc for plankton group (PG), and pelagic fish group (PFG) in the north and the south of Cap Blanc.



Trend in Diel vertical migration (DVM)

Differences to day and night relative acoustic density (ΔDVM,) for (left) the plankton group and pelagic fish group (right) echo classes in north and south of Cap Blanc.





- SST is the most important driver of acoustic density variation since high acoustic density was found in the southern part of Cap Blanc where SST warming was more significant over the study period.

- The absence of spatial shift in pelagic abundance for all trophic groups might be related to the high productivity of the CCLME and the SST warming pattern.

- The south of Cap Blanc, characterized by a significant increase in SST associated with a stable UW, seems to be a more favorable habitat for pelagic species.

- The relative acoustic density is 10 times higher for the PFG than for the PG, which corroborates existing studies suggesting the existence of a factor of 10 between the biomass of fish and that of zooplankton in the marine food web.

- The adaptive DVM behavior explain the higher extent of DVM (i.e., high ΔDVM) reported for PG. Indeed, small pelagic fishes disperse widely at night and aggregate by day while planktonic organism performs normal DVM.

- The absence of DVM trend show that the main functional pelagic groups in the CCLME remain stable in the system during the study period.

- All environmental variables increased significantly, except in the area south of Cap Blanc where SSC deceased and the UW was stable.

- No significant long-term trends were observed on the relative acoustic density for the two trophic level groups, their latitudinal displacement, and their DVM.

- Despite the presence of major stressors, the marine pelagic ressources, mainly fish and plankton remained relatively stable over the two decades, advancing our understanding on the resistance of this east border upwelling system.

THANK YOU FOR LISTENING !

For more details:

Diogoul, N., Brehmer, P., Demarcq, H., El Ayoubi, S., Thiam, A., Sarre, A., Mouget, A., and Perrot, Y.: On the robustness of an eastern boundary upwelling ecosystem exposed to multiple stressors, Sci. Rep., 11, 1908, https://doi.org/10.1038/s41598-021-81549-1, 2021.