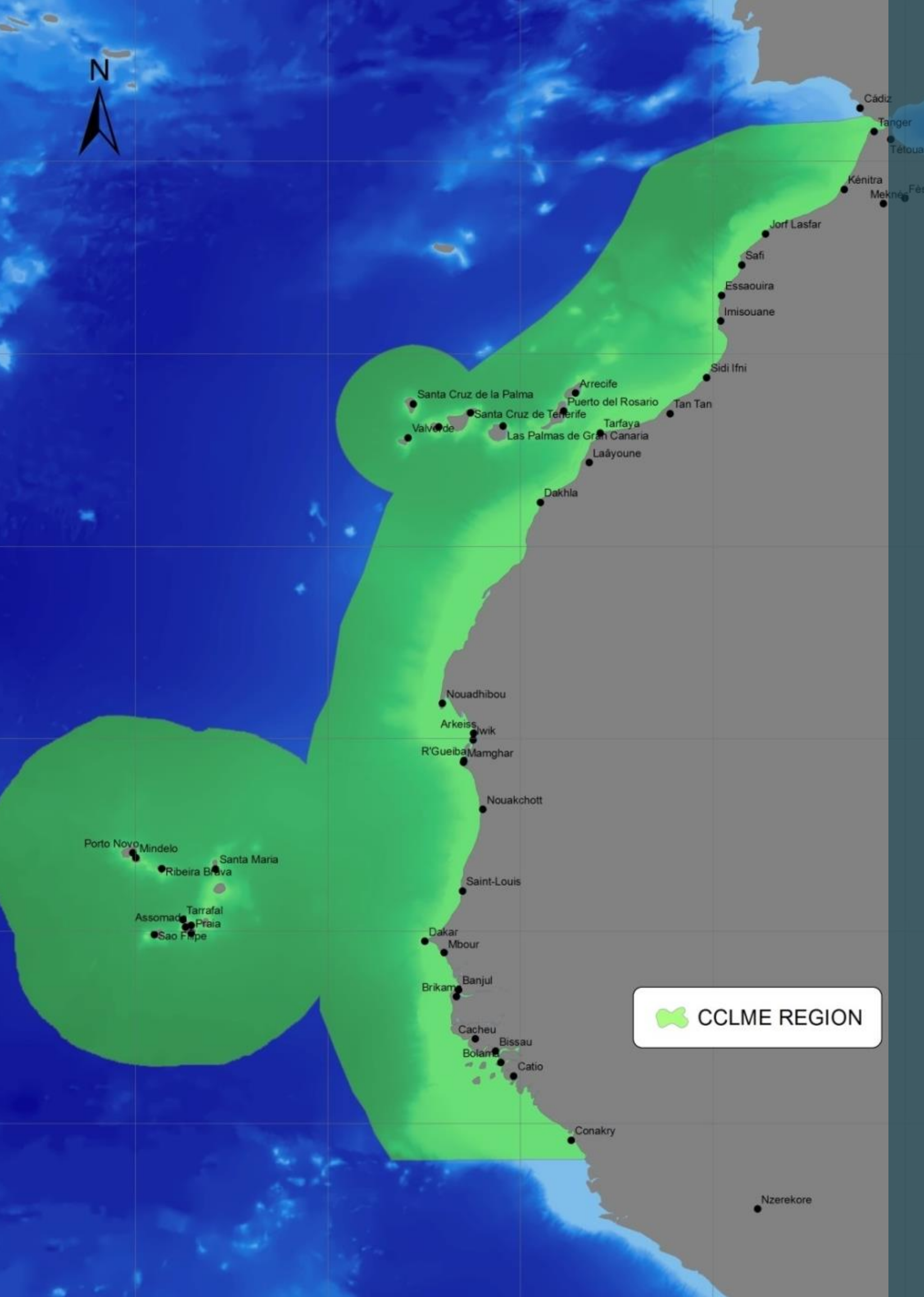

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CASE STUDY: Analysis of the Canary Current Large Marine Ecosystem Upwelling Index using the IOC application *CCLME Data Analytic Viewer*

Itahisa DÉNIZ-GONZÁLEZ

Hands-on Workshop on "The use of the CCLME Eco-GIS Viewer"

11-13 July 2017

OBJECTIVE

The main aim of this Case Study is
to test the CCLME Eco-GIS Viewer
developed under the frame of the project

http://www.ideo-cclme.ieo.es/

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HOW?

Using several tools while trying to reproduce some findings and to verify some statements in the scientific article:

Benazzouz, A., Mordane, S., Orbi, A., Chagdali, M., Hilmi, K., Atillah, A., Pelegrí, J. L. and Demarcq, H. 2014. An improved coastal upwelling index from sea surface temperature using satellite-based approach – The case of the Canary Current upwelling system. *Continental Shelf Research*, Vol. 81, pp. 38-54. doi:10.1016/j.csr.2014.03.012.

https://www.researchgate.net/publication/261327408_An_improved_coastal_upwelling_index_from_sea_surface_temperature_using_satellite-based_approach_-_The_case_of_the_Canary_Current_upwelling_system

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Benazzouz et al., 2014

The aim of that article was to develop a
new methodology to compute an improved
<u>Sea Surface Temperature (SST)-based upwelling index</u>,
while reviewing various existing methodologies.

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CASE STUDY AREA

CCLME: from ≈ 36°N 5°W to ≈ 11°N 16°W

EEZ of: Morocco, Western Sahara, Mauritania, Senegal, Gambia, Guinea-Bissau and Spain (Canary Islands). Guinea and Cabo Verde also taken into account → influenced by the Canary Current.

+ The west coast of the Iberian Peninsula

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METHODOLOGY: TOOLS & DATASETS

The following tools have been used:

- Bathymetry mapping and transects
- CCLME Upwelling Index
- GIS SST and CHL data and difference analysis
- Spatial-temporal data viewer
- Oceanographic transects
- Using my own data.

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RESULTS AND DISCUSSION

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CCLME UPWELLING INDEX TOOL

IMPORTANT : **This tool calculates a <u>wind-based</u> Upwelling Index**

The Upwelling Index tested:

- Uses the **Sea Level Pressure dat**a (SLP, hPa) from the WXMAP Model, extracted from the FNMOC database, US Navy).

- Is based in the **Bakun methodology** (Bakun, 1973) and is explained by Gonzalez-Nuevo et al. (2014) → follow and compare the results with those from Lavin et al. (1991), who used a different dataset to do the analysis.

- **Units**: $m^3\ s^{-1}\ km^{-1}$.

www.indicedeafloramiento.ieo.es

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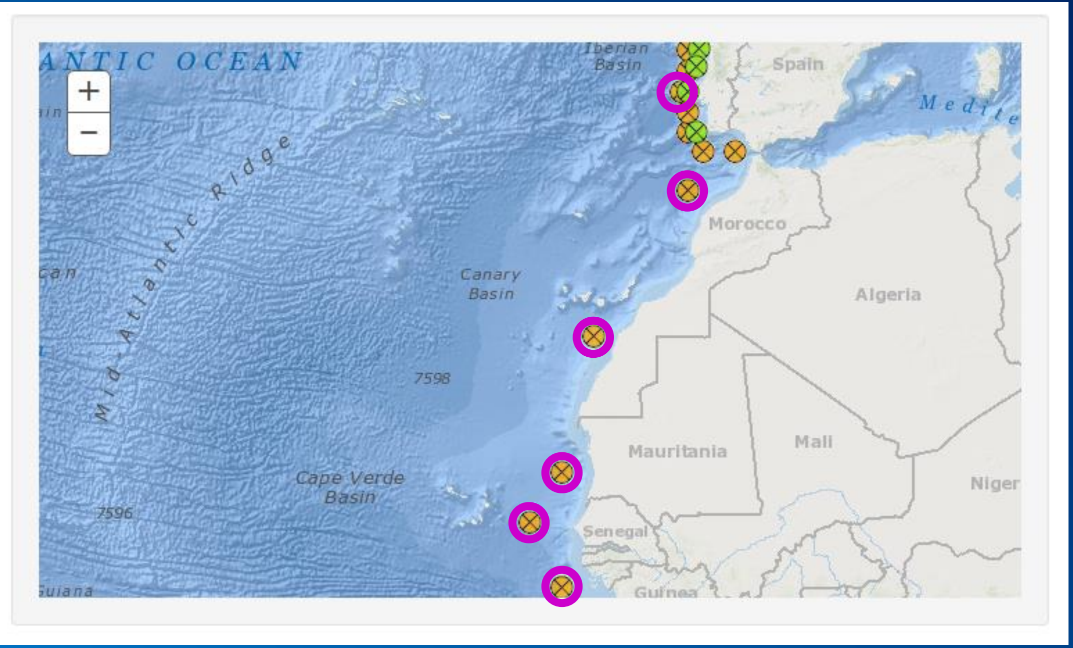
CCLME UPWELLING INDEX TOOL



Reference point	Latitude (°N)	Longitude (°E)	In Benazzouz et al. 2014 (latitude)
Figueira da Foz	40	-10	Portugal (37-43°N)
Casablanca	34	-10	North Morocco (33-36°N)
Canarias	26	-16	In the limit between Central Morocco (26-33°N) and South Morocco (21-26°N)
Mauritania	18	-18	
Dakar	15	-20	Senegal and Mauritania (9-21°N)
Guineas	11	-18	

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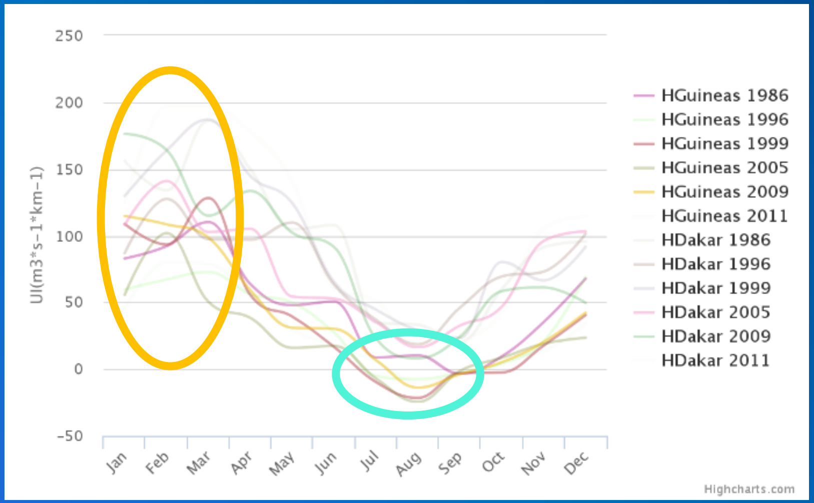
CCLME UPWELLING INDEX TOOL

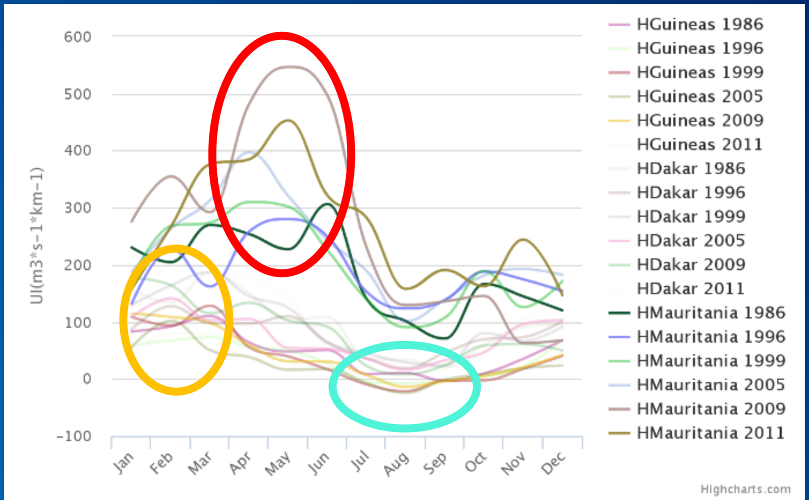
Benazzouz et al. (2014):

- The greatest intensity in the **southern area (9-21°N)** in winter and spring.
- 1986, 1996, 1999, 2005, 2009 and 2011 associated to strong upwelling seasons only in the southern part of the system.
- The intrusion of warm Guinea water generates negative upwelling indices during summer (when comparing various SST-based indices).

(a)



(b)



Comparison of the variability of the UI_{FNMOC} (in $m^3\ s^{-1}\ km^{-1}$) for the years: 1986, 1996, 1999, 2005, 2009 and 2011 (a) in Dakar and Guineas reference points; and (b) in Mauritania, Dakar and Guineas reference points. Extracted from the CCLME Data Analytic viewer. Data source: IEO.

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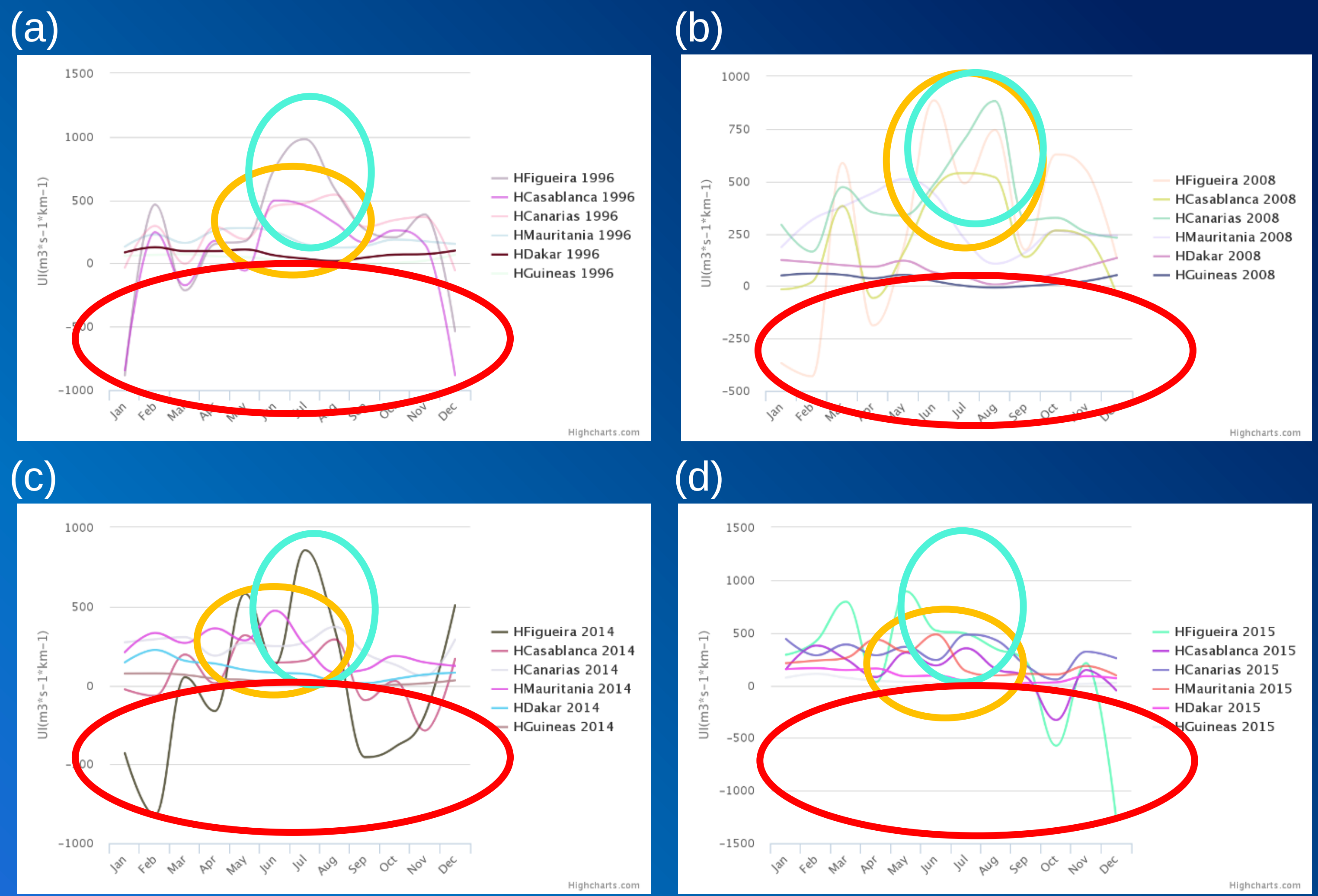
CCLME UPWELLING INDEX TOOL

Benazzouz et al. (2014):

- The central region of the Northwest African upwelling (21–26°N) is characterized by a quasi-permanent upwelling, and further north marked by a strongly seasonal upwelling from April to September
- The anomalies are sometimes out of phase, i.e. 1996.
- In Portugal (37–43°N), the upwelling is very seasonal from June to August



UI_{FNMOC} (in m^3 s^{-1} km^{-1}) calculated for examples of years in which the northern part of the region (Figueira da Foz, Casablanca and Canarias reference points) is out of phase in comparison with the southern part of the region (Mauritania, Dakar and Guineas reference points): (a) 1996; (b) 2008; (c) 2014; (d) 2015. Extracted from the CCLME Data Analytic viewer. Data source: IEO.

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CCLME UPWELLING INDEX TOOL

However, **negatives values** are mainly obtained at Figueira da Foz and Casablanca reference points, which does not occur in Benazzouz et al. (2014). They always obtain positive values, except for an interruption at the Strait of Gibraltar due to the input of warmest Mediterranean water.

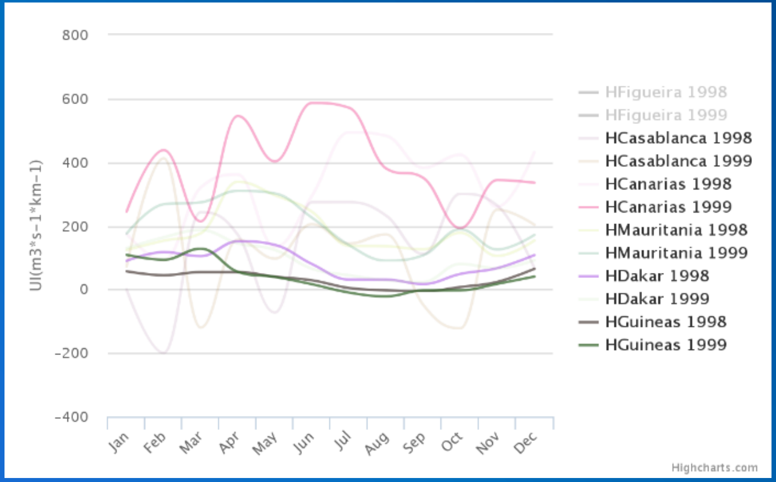
Gonzalez-Nuevo et al. (2014) : **UI derived from SST data cannot reproduce properly the upwelling variability in the NW Iberian region due to the fact that the region is strongly influenced by mesoscale and regional scale oceanic processes →** this could explain the different results obtained for both indices in this area

CCLME UPWELLING INDEX TOOL

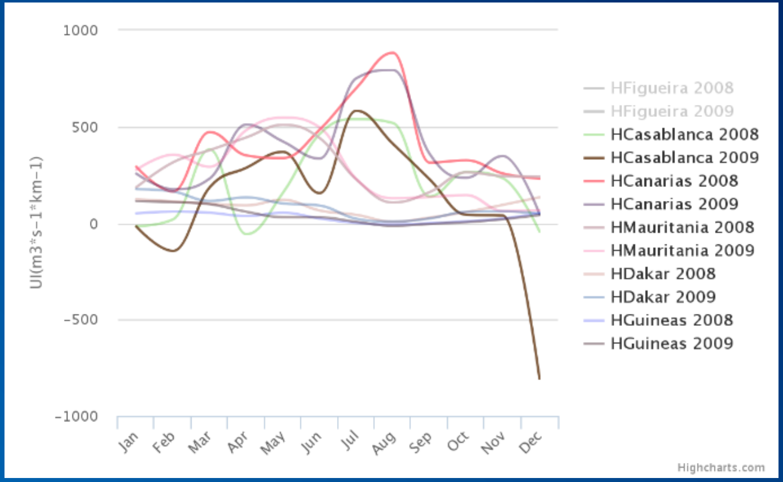
Benazzouz et al. (2014):

- Only a few years present clear anomalies for the whole system, as 1998-1999 and 2008-2009.

(a)



(b)



Comparison of the UI_{FNMOC} (in $m^3\ s^{-1}\ km^{-1}$) in the 4 points in NW Africa during: (a) 1998-1999; (b) 2008-2009. Extracted from the CCLME Eco-GIS Viewer. Data source: IEO.

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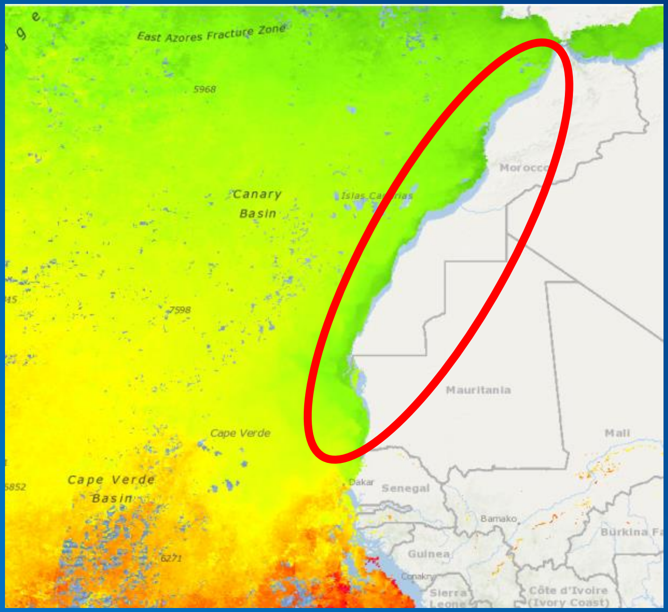
GIS SST AND CHL DATA AND ANOMALY ANALYSIS

(a)



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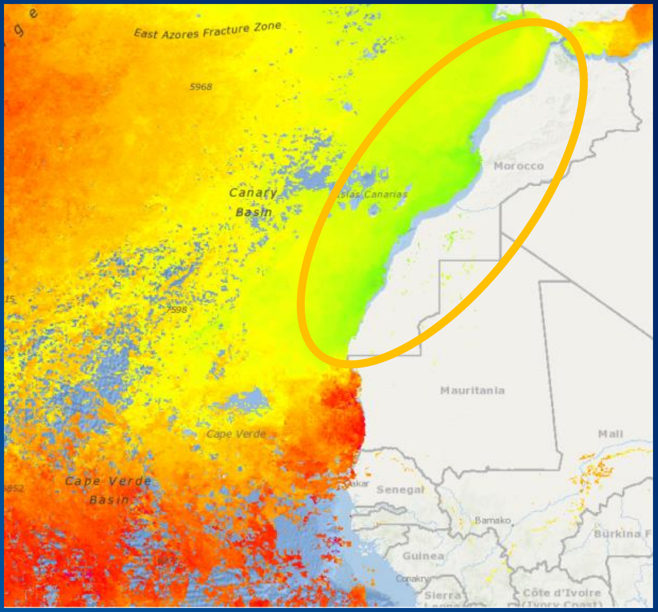

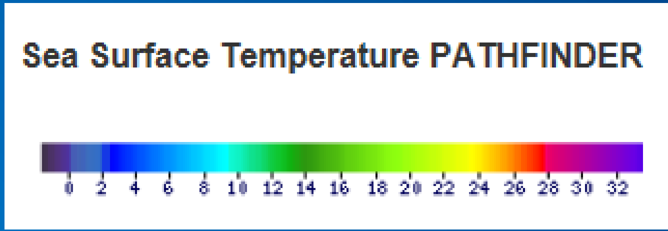

SST (in °C) in: (a) May 2008, and (b) August 2008. Maps extracted from the CCLME Eco-GIS Viewer. Data source: NOAA AVHRR.

Confirms the spatio-temporal variability described by Benazzouz et al. (2014).

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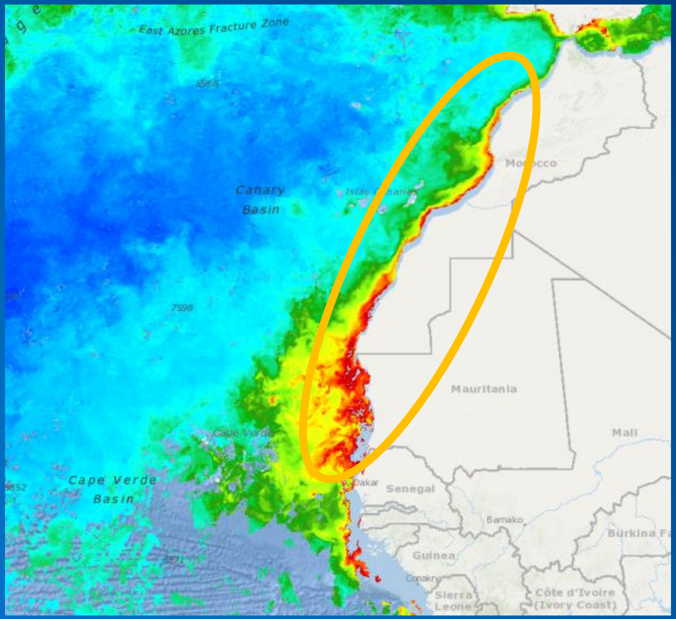
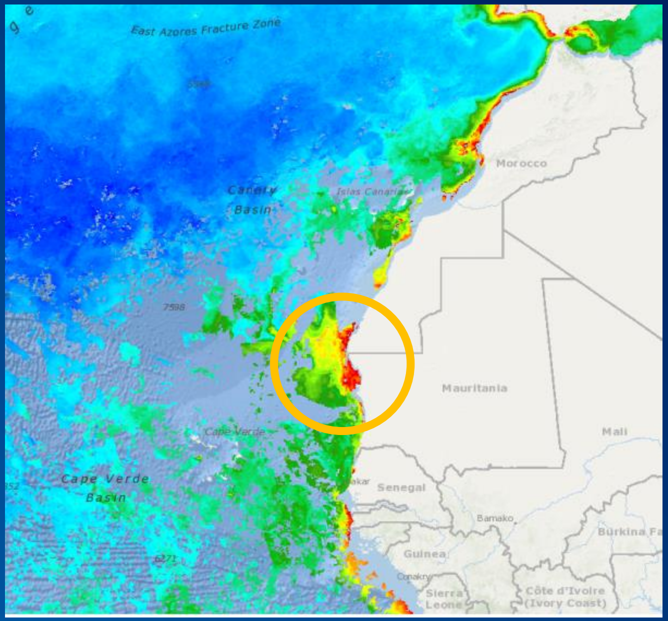
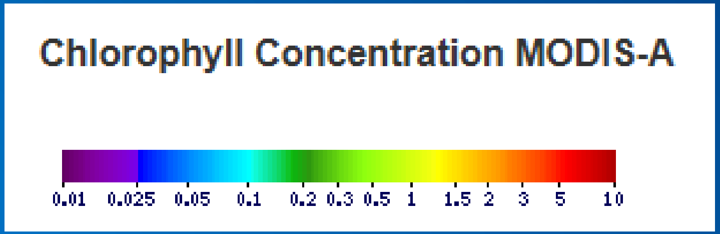
GIS SST AND CHL DATA AND ANOMALY ANALYSIS

(a)



(b)





Chlorophyll concentration (in mg m^{-3}) in: (a) May 2008, and (b) August 2008. Maps extracted from the CCLME Eco-GIS Viewer.
Data source: NASA MODIS-AQUA.

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Therefore, in Mauritania region, confirms **<u>the spatio-temporal variability of the upwelling explained by Benazzouz et al. (2014):</u>** the strongest upwelling seems to take **place during spring (April-June),** instead of during summertime.

These results were obtained for the upwelling index at the Mauritania reference point and are consistent with the SST and Chl concentration distribution maps, obtained for May and August 2008.

<u>However, further analysis of the data is needed.</u>

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BATHYMETRY MAPPING AND TRANSECTS

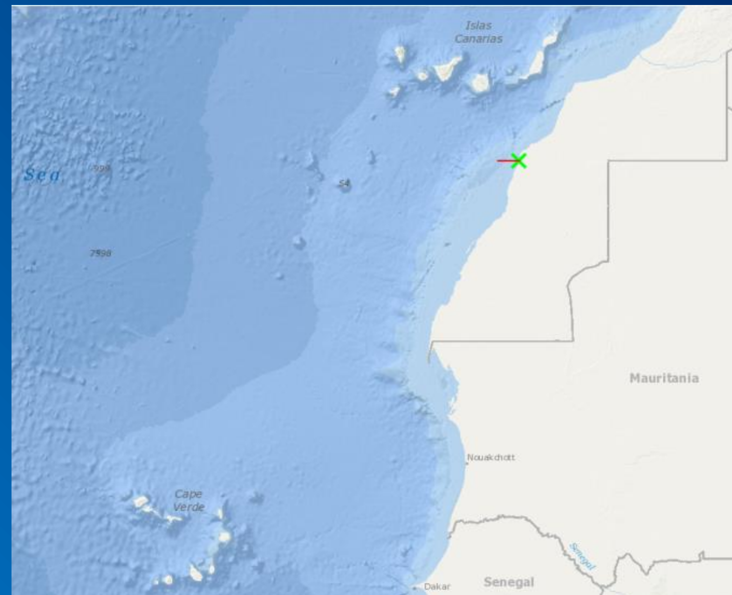
Benazzouz et al. (2014):

- The steepness of the continental slope acts as a guide for the emergence of the upwelled waters at the sea surface.

- Steepness of the continental slope was studied taking into account the proximity of 50 m and 200 m isobaths.

BATHYMETRY MAPPING AND TRANSECTS

a)



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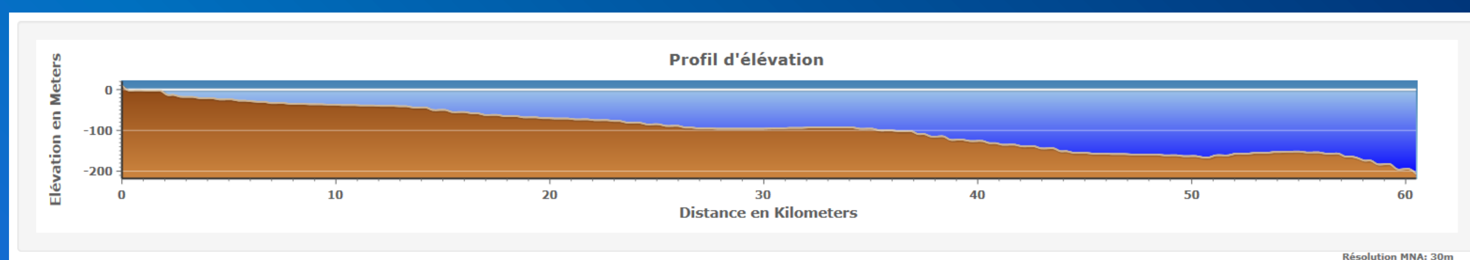

From the top to the bottom: a) transect from the African coast at the east to approximately 15.1°W at the west, at the latitude of approximately 26°N (the starting point of the transect in (b) is marked with a green cross); b) elevation profile. Map and profiles extracted from the CCLME Eco-GIS Viewer.
Data source: GEBCO_08 Grid.

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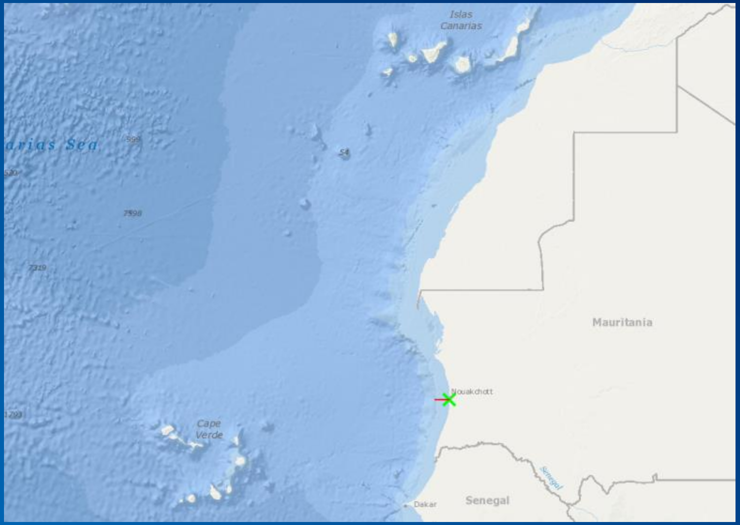
BATHYMETRY MAPPING AND TRANSECTS

a)



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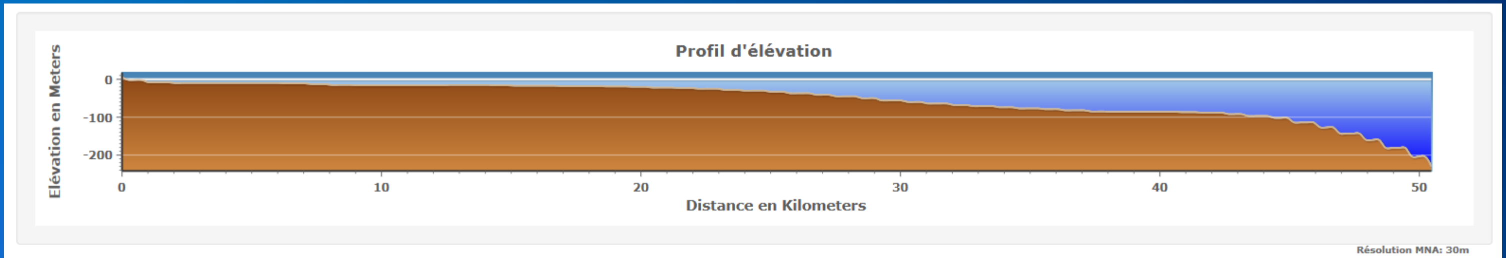

From the top to the bottom: a) transect from the African coast at the east to approximately 16.5°W at the west, at the latitude of approximately 18°N (the starting point of the transect in (b) is marked with a green cross); b) elevation profile. Map and profiles extracted from the CCLME Eco-GIS Viewer. Data source: GEBCO_08 Grid.

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BATHYMETRY MAPPING AND TRANSECTS

(coordinates and distances are approximate:)

At 26°N the difference of height between 50 m depth and 200 m depth is reached in a distance of around 45 km in the x-axis (which means a slope of around 0.0033).

At 18°N, the difference of height between 50 m depth and 200 m depth is reached in a distance of around 22 km in the x-axis (which means a slope of around 0.0068).

Therefore, even if a generalisation cannot be done with this imprecise information → the African steepness at around 18°N is much more marked than at around 26°N.

It seems to be for this reason that the upwelling is close to the coast in Morocco-Western Sahara regions, even if a secondary upwelling cell may appear at the vicinity of the continental slope (Benazzouz et al., 2014).

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CONCLUSIONS

This testing phase has allowed to highlight ideas that require attention and action mainly in terms of:

(i) manipulation of the tools and intuitiveness;
(ii) usefulness of the data and the representations displayed;
(iii) obtaining help and complementary information; and
(iv) downloading the charts and the data for using in other analysis and/or in other software.

CHECKLIST

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Thank you very much!

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