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Long-term environmental variability in NW Iberian waters: influence over pelagic and demersal fish stocks

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Abstract:

A set of environmental time-series from 1967 to 2012 are analyzed in order to isolate the most important patterns of variability in the data and detect possible regime shifts with ecological consequences in the NW Iberian waters. Using climatic and oceanographic data at different scales the aim is to identify the variables that explain most of the variance and try to clear up the fluctuation of the main demersal and pelagic fish stocks in the region.

Material and methods:

Principal Component Analysis (PCA) have been used to identify the most important modes of variability among climate and fisheries time series. Data in the two PCAs were normalized.

METEOROLOGICAL AND OCEANOGRAPHIC data:

- Solar sunspot (MS).
- Standardized Northern Hemisphere Teleconnection Indices: North Atlantic Oscillation (NAO), Eastern Atlantic Pattern (EA), East Atlantic/West Russian Pattern (EA/WR), Scandinavian Pattern (SCA), Tropical/Northern Hemisphere Pattern (TNH), Polar/Eurasian Pattern (POL).
- Position of the North Wall of the Gulf Stream (GSNW), Atlantic Multidecadal Oscillation (AMO).
- Regional Indices: Upwelling Index (UIa) and Poleward Index (IPC) at 43N 11W.
- Average annual precipitation (PmGC, PmMS).
- International Comprehensive Ocean-Atmosphere Data Set (ICOADS, 1-degree and reanalysis 2.5-degree): In order to not use an unique point that represents all the study area, Principal Component Analysis (PCA) on spatial changes in ICOADS variables have been made. 9 new variables are obtained (Fig.1).

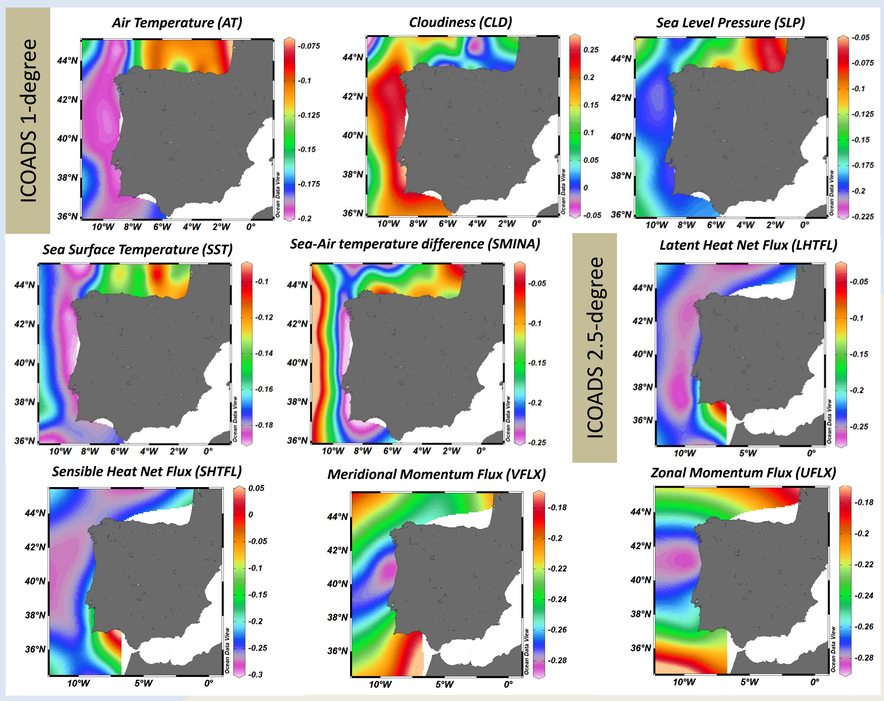

Fig.1. Spatial distribution of loadings of the first principal component from the ICOADS variables. The PC loadings indicate the correlations between individual time series of each point and the associated PC.

FISHERIES data:

- Landings of blue whiting, hake, mackerel, horse mackerel, sardine and anchovy in VIIIc and IXa ICES areas from both, ICES official and ICES evaluation databases.

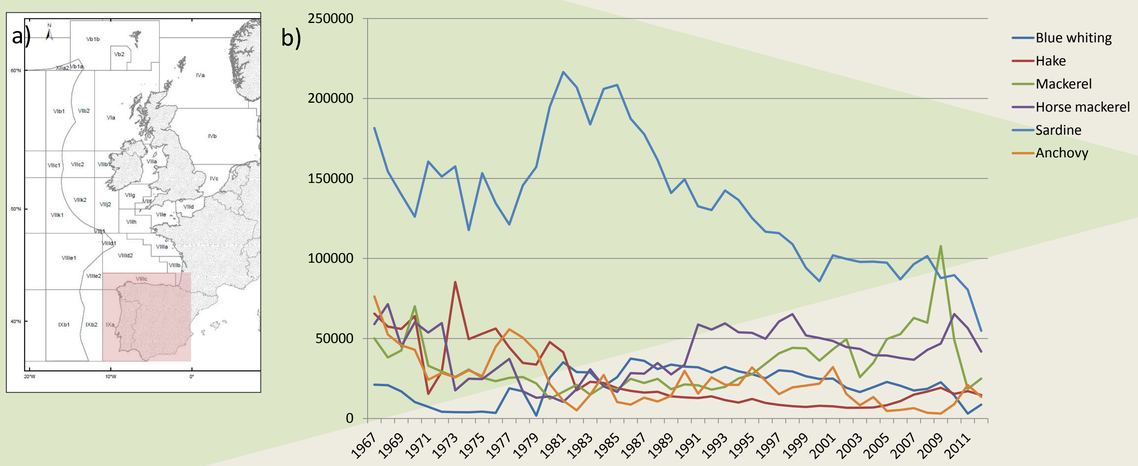

Fig.2. a) ICES areas. The study area is highlighted in red. b) Landings (Tm).

Results:

Three new variables (PCs) summarized the climatic variability. The first and second PCs account for the 23% and 16% of the total variance respectively. PC1_Climate is related mainly with EA, AMO and SST whereas PC2_Climate gather regional variables like UI, VFLX and SMINA (Fig.3a).

From fisheries time series two new variables have been obtained. PC1_Fisheries (36% of the total variance) and PC2_Fisheries (30%). The first one is mainly correlated with hake and sardine and inversely with mackerel. The second one with blue whiting. Sardine and anchovy contribute inversely (Fig.3b).

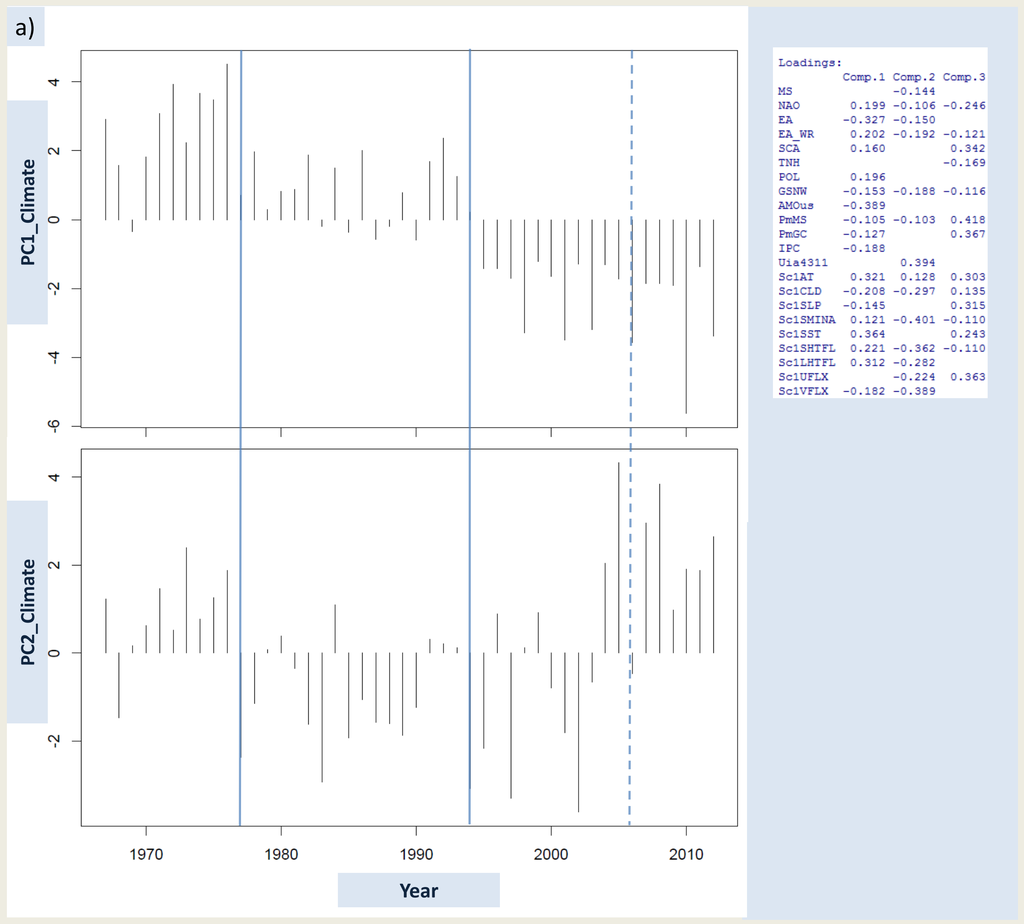

Fig.3. First and second PCs of a) climate and b) fisheries time series. Blue bars indicate probable regime shifts. Loadings are indicated at right.

Discussion:

Two probable regime shifts have been identified, one in the late 1970s and the other in the early 1990s, like those detected for another authors (Hare and Mantua, 2000; Borges M.F. (Ed), 2013). A third one, in the mid-2000s, around 10 years after the last one, could be pointed. Additional time-series analysis methods should be used to assess the statistical significance of these regimen shifts and its magnitude.