

# Influence of ocean climate on southern hake (*Merluccius merluccius*) stock variability: a regime shifts study

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## Abstract:

A set of ocean-meteorological time series (1967-2015) at different scales, global, regional and local, is analyzed in order to detect changes in the environmental regime that can explain part of the fluctuations of the hake fishery in the Iberian Atlantic shelf and its adjacent oceanic waters (36°N - 44.5°N). Hake landings and recruitment show a positive regime shift around 2006 as well as the environment. We analyze the environmental variables that could led to this change.

## Environmental variability:

A Principal Component Analysis (PCA) was made with 16 variables in order to know the main modes of environmental variability in the study area. Three main modes explain hydro-climatic variability.

Three **regime shifts** were detected, also identified in other regions of the North Atlantic. 2005/06 regime shift is detected in the three main modes:

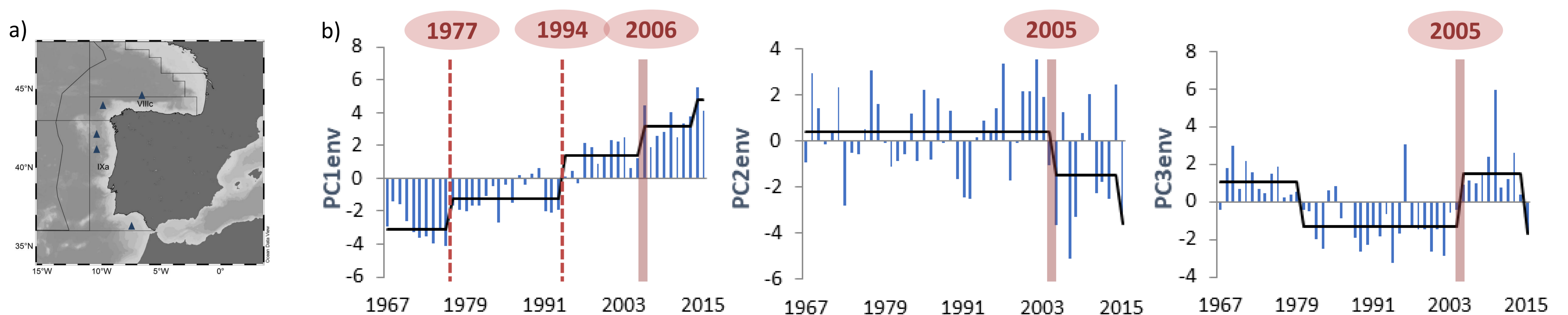


Fig 1 a) ICES areas and upwelling index stations. b) Environmental principal components time series and regime shifts.

## Hake variability:

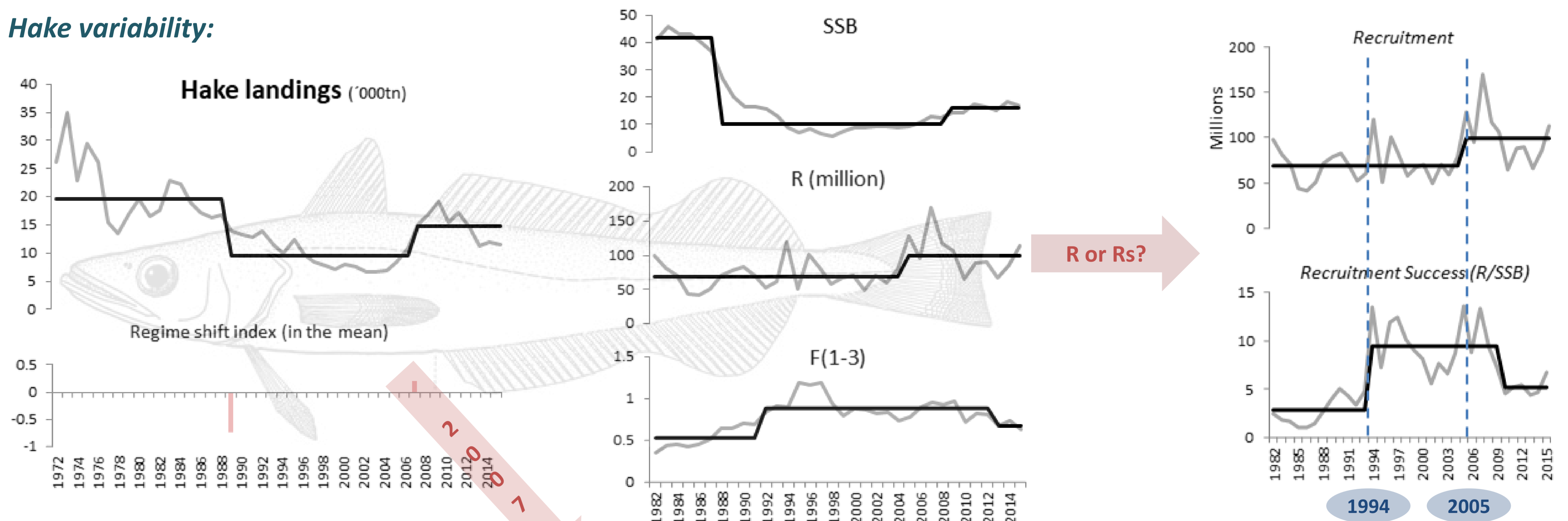
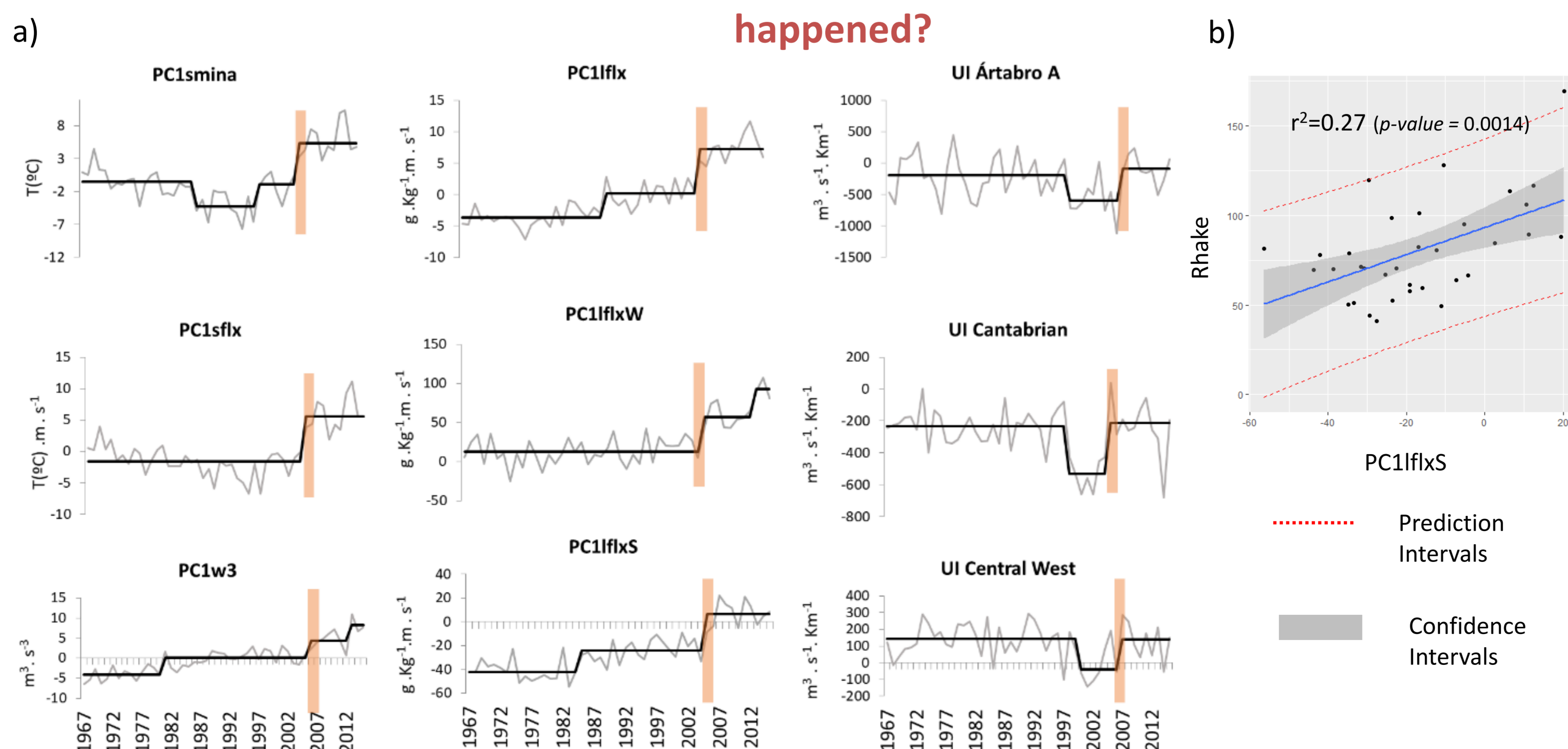


Fig 2 Hake landings, SSB, recruitment (R), recruitment success (Rs), fishing mortality (F) and regime shifts.

What happened?



\*UI Central West: Upwelling Index in north-central Atlantic area; UI Cantabrian: in Cantabrian Sea; UI Ártabro: in Gulf Ártabro; PC1smina: first spatial component of sea-air temperature difference, PC1w3: of scalar wind cubed; PC1lflx, WS: of latent heat parameter, winter, summer; PC1sflx: of sensible heat parameter.

Fig 3 a) Environmental variables that changed around 2007. b) Regression model between hake recruitment and latent heat parameter in summer.

## Discussion:

The 2005/06 environmental regime shift, does not appear to be triggered by any of the global scale variables used. Regional variables such as smina or lflx, undergo a second positive change, reinforcing the change of the mid-90s. On the contrary, most of the breeding areas return to the situation of average upwelling prior to the negative change suffered at the end of the 90s, which seems favor southern hake stock. This recovery would begin with the 1994 environmental change which, although not so propitious, would have favored the success recruitment, thus avoiding a more pronounced decline of the stock in those years.