

Temporal changes in the phytoplankton community along the French coast of the eastern English Channel and the southern Bight of the North Sea

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EUTROPHICATION

COASTAL ECOSYSTEMS

CLIMATE CHANGES



LONG-TERM VARIATIONS IN PHYTOPLANKTON COMMUNITIES

- Biomass
- Community composition
- Phenology



- DIVERSITY
- INCREASING VULNERABILITY
- PROLIFERATION OF TOXIC PHYTOPLANKTON

- HUMAN HEALTH**
- FISHERIES**
- AQUACULTURE**

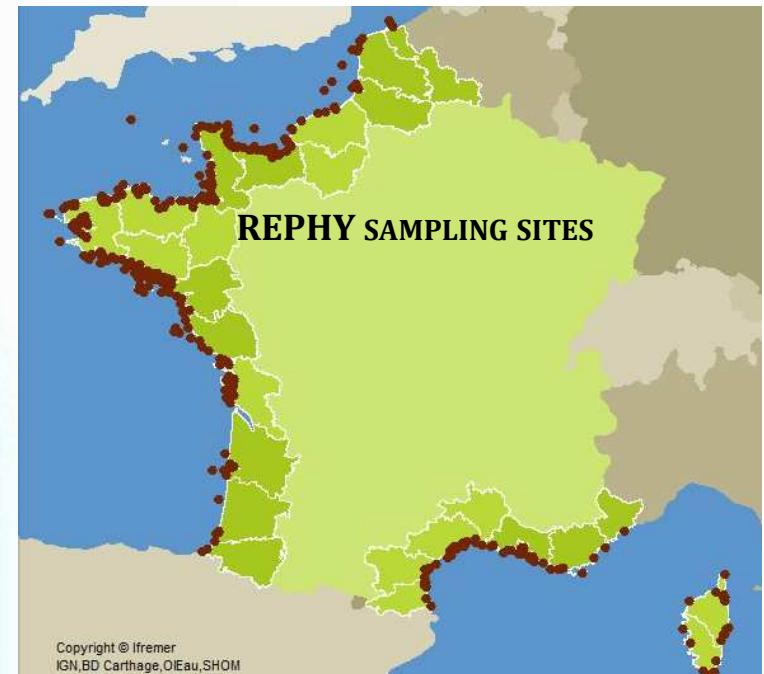
Edwards and Richardson, 2004

Suikkanen *et al.*, 2007

REPHY - PHYTOPLANKTON AND PHYCOTOXIN MONITORING NETWORK

Implemented and managed by the IFREMER with two main objectives:

- **describe spatial and temporal dynamics** of phytoplankton populations
- **detect and monitor** phycotoxin-producing species involved in toxic shellfish outbreaks



- Macro-tidal regime

- Freshwater inputs

- Seine river ($\sim 400 \text{ m}^3 \text{ s}^{-1}$)
- Somme river ($\sim 37 \text{ m}^3 \text{ s}^{-1}$)
- Secondary watersheds

- Intense and regular blooms of the foaming and noxious species of *Phaeocystis*



74% - 90%

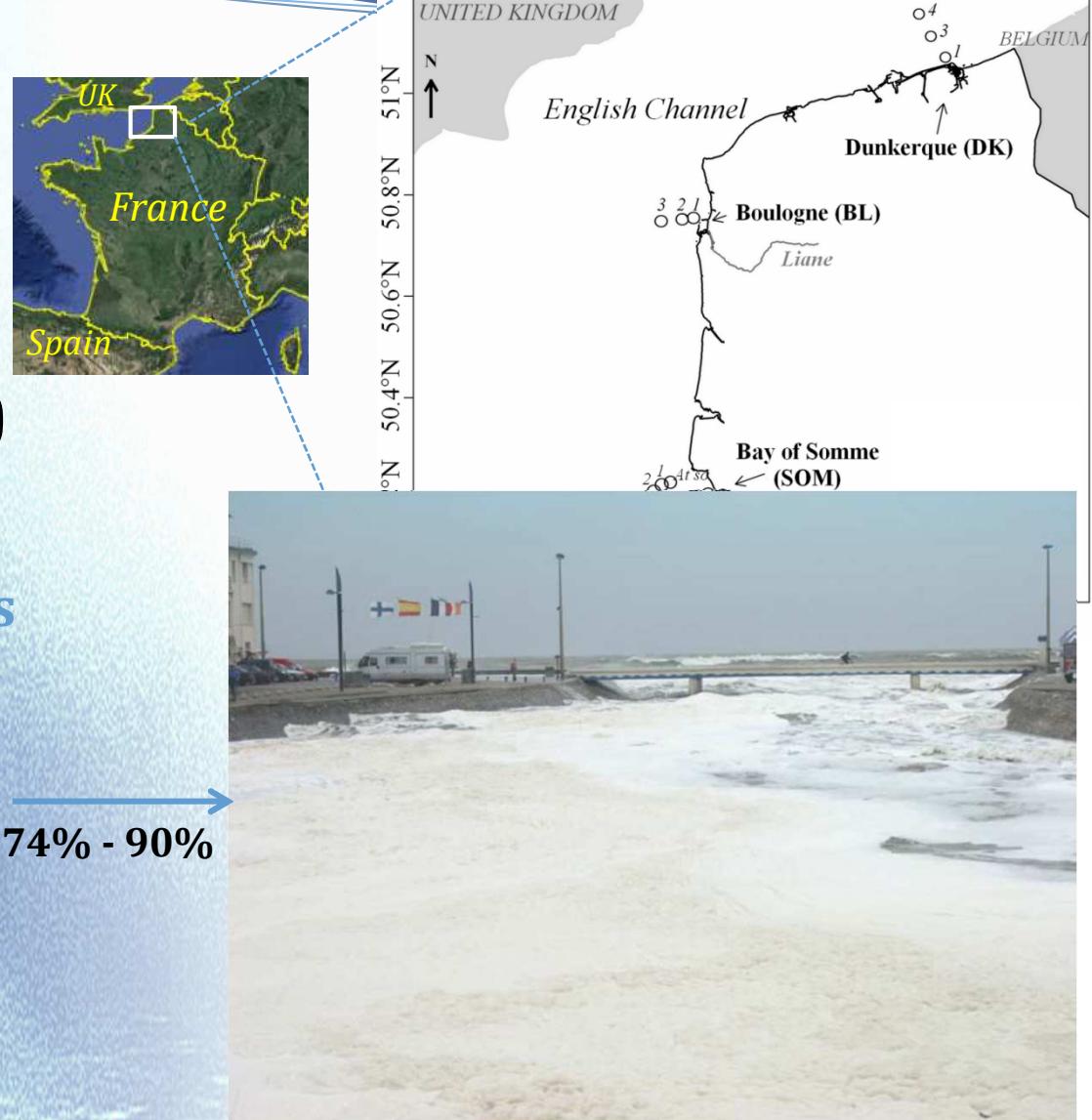


Photo: P. Hébert, april 2002

Characterize and quantify long term changes in the phytoplankton community structure through different taxonomic scales

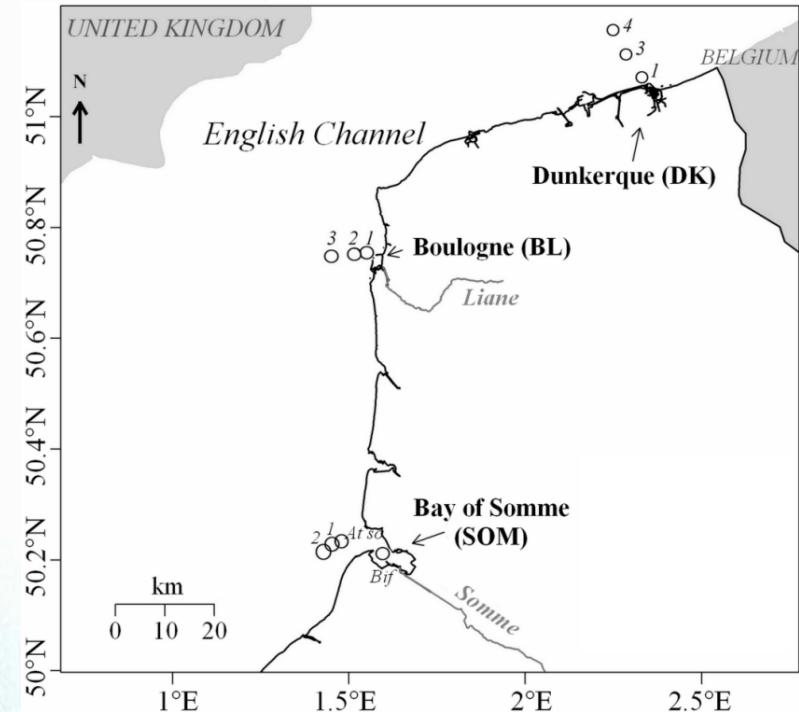
Study the role of hydrological parameters and large-scale climatic variability

DATA SETS: MONITORING NETWORKS REPHY AND SRN

- **Sampling sites:** three coast-to-offshore transects
- **Period:** 1992 – 2011
- **Sampling frequency:** bimonthly to monthly

MEASURED PARAMETERS (BETWEEN 0-1M)

- Phytoplankton
- T°C – salinity
- [nutrients]: silicates, phosphates dissolved inorganic nitrogen ($DIN = NH_4^+ + NO_3^- + NO_2^-$)



PRELIMINARY PROCESSING OF PHYTOPLANKTON DATA

- ensures homogenous data regarding taxonomic classification

LONG TEMPORAL CHANGES IN PHYTOPLANKTON AND ENVIRONMENTAL DATA

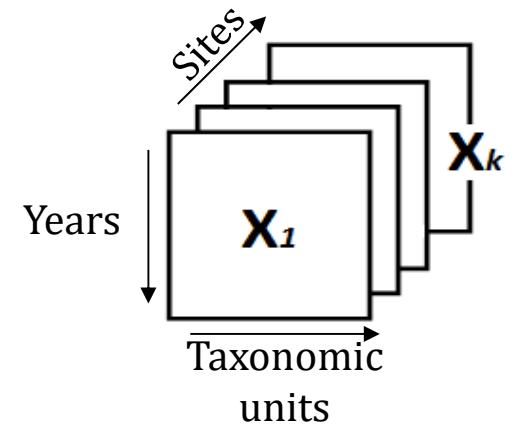
✓ DYNAMIC LINEAR MODEL (DLM)

Two components: trend and a seasonal component

- missing values
- adding exogenous information
- adapted treatment of outliers

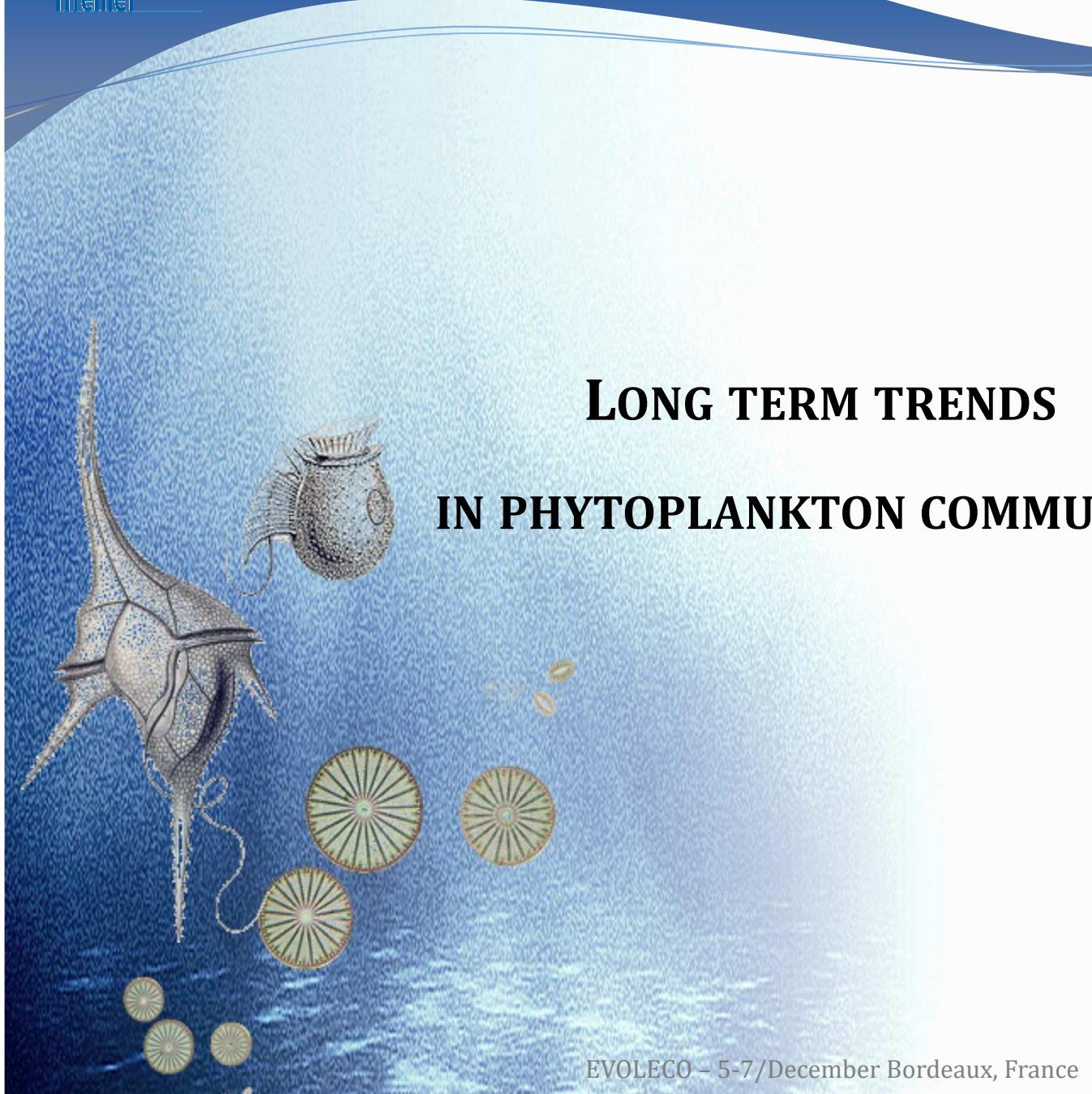
✓ PARTIAL TRIADIC ANALYSIS (PTA)

- temporal patterns of the phytoplankton community composition
- spatial stability of the temporal structure



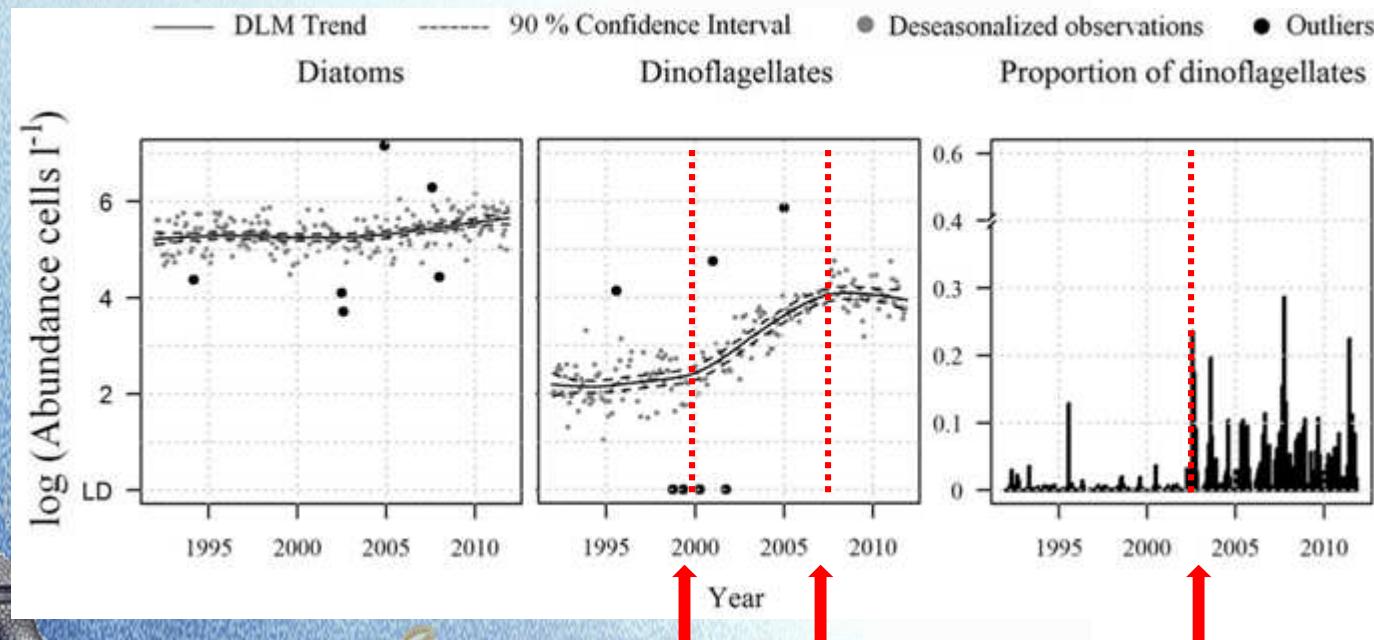
✓ REDUNDANCY ANALYSIS (RDA)

- Relationship between phytoplankton, environmental factors and climatic indices (North Atlantic Oscillation NAO_w, Atlantic Multidecadal Oscillation)



LONG TERM TRENDS IN PHYTOPLANKTON COMMUNITY

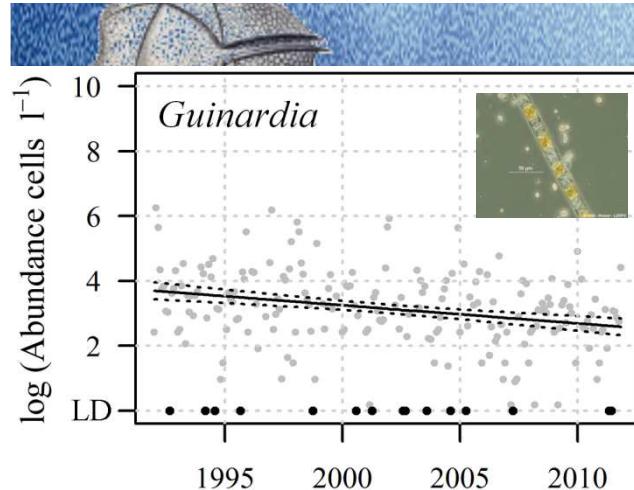
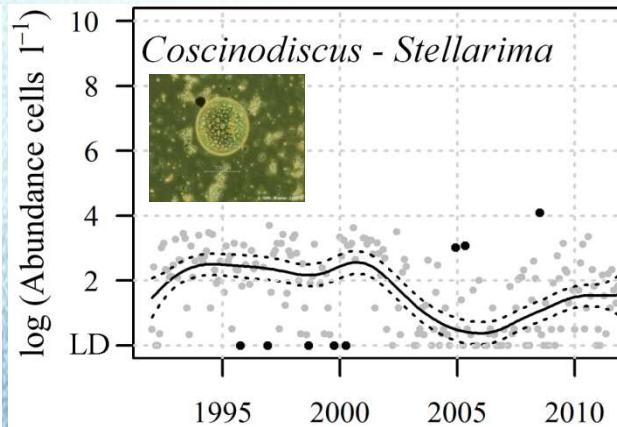
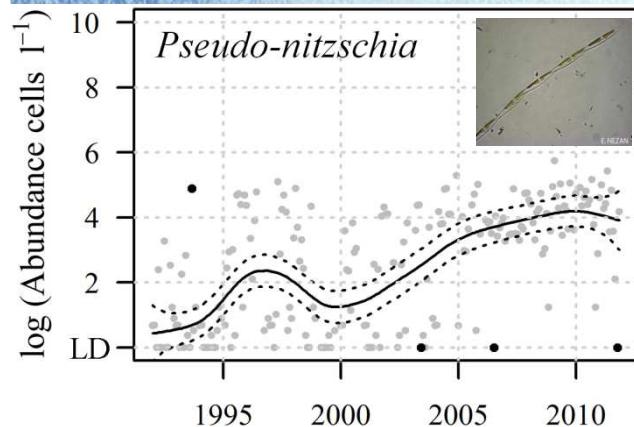
Diatoms & Dinoflagellates groups



- Minor changes in the abundance of diatoms
- Pronounced variations in dinoflagellates
 - increased mean level by 60%
 - this implies an increasing trend in the proportion of dinoflagellates relative to diatoms

Trends in specific taxonomic units

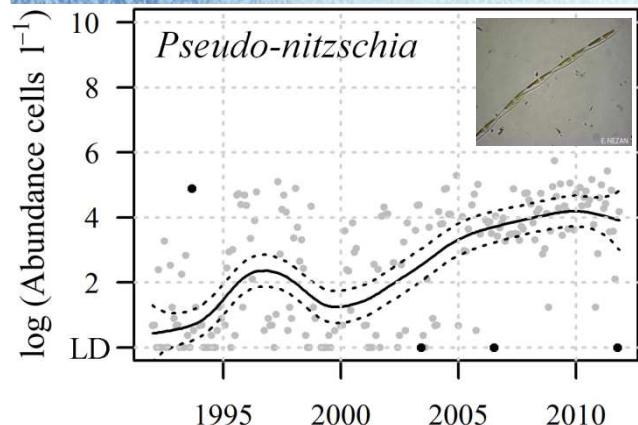
DIATOMS



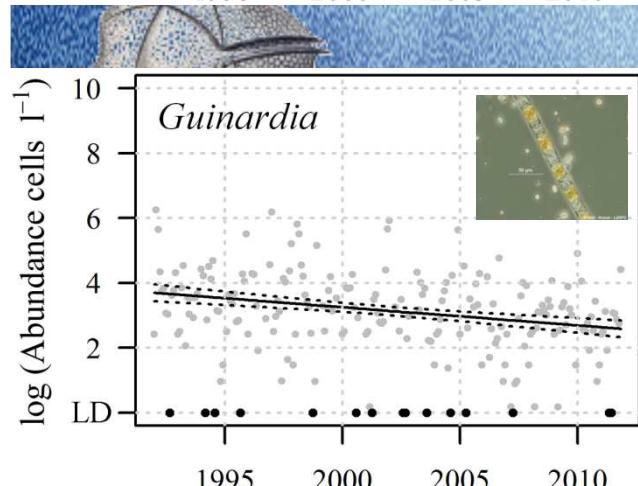
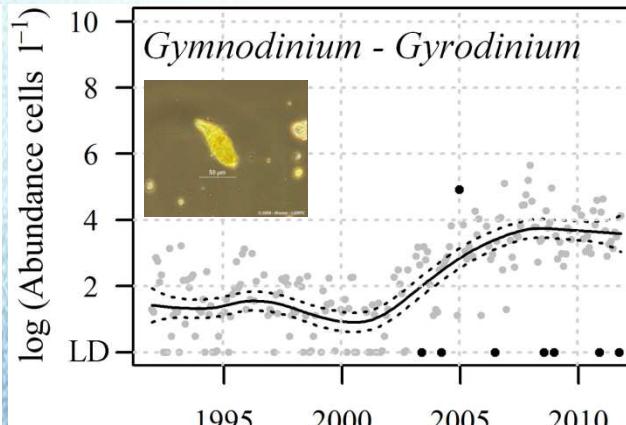
- Trends patterns depends on specific taxonomic units

Trends in specific taxonomic units

DIATOMS



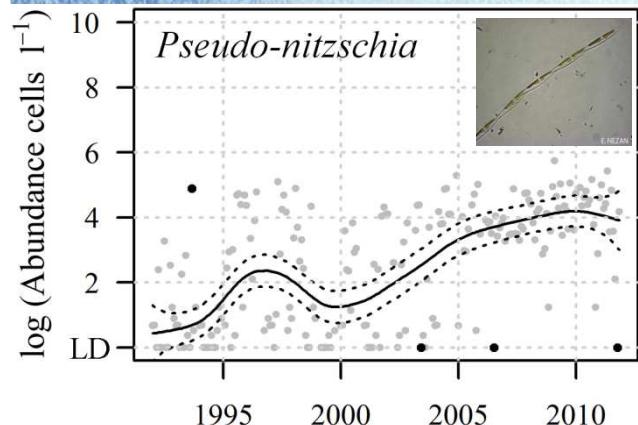
DINOFLAGELLATES



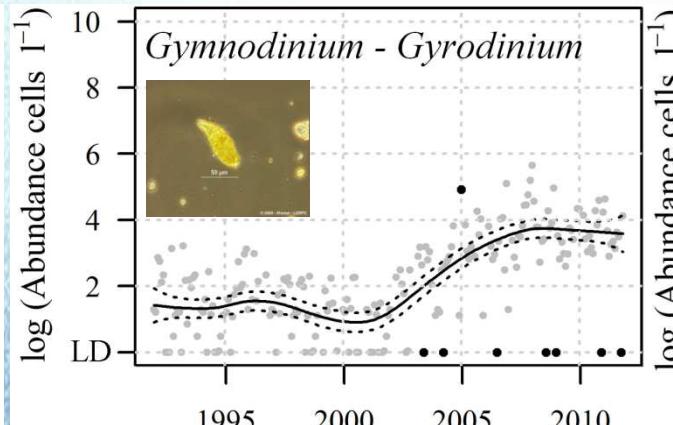
- *Gymnodinium - Gyrodinium* reflects well the patterns of dinoflagellates group

Trends in specific taxonomic units

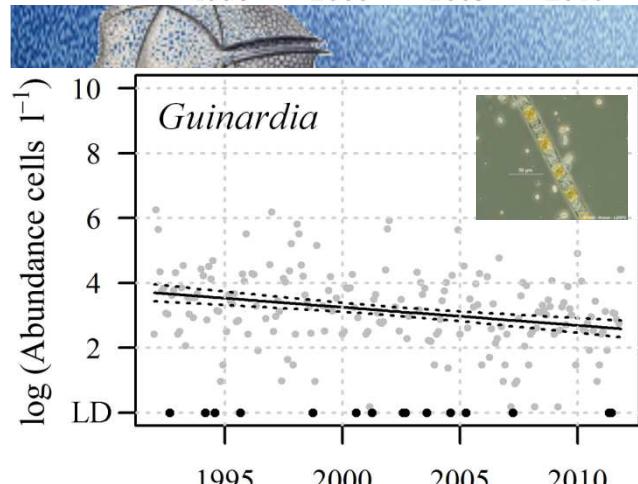
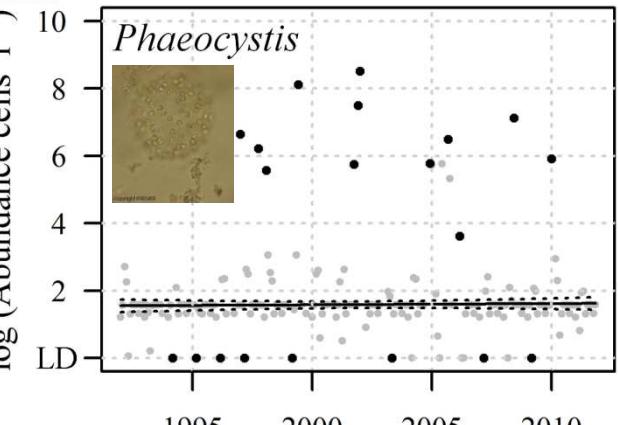
DIATOMS



DINOFLAGELLATES



PHAEOPHYCESTIS



- *Gymnodinium - Gyrodinium* reflects well the patterns of dinoflagellates group

LONG TERM TRENDS IN PHYTOPLANKTON

Trends in community composition

- **First period (1992 - 2001)**

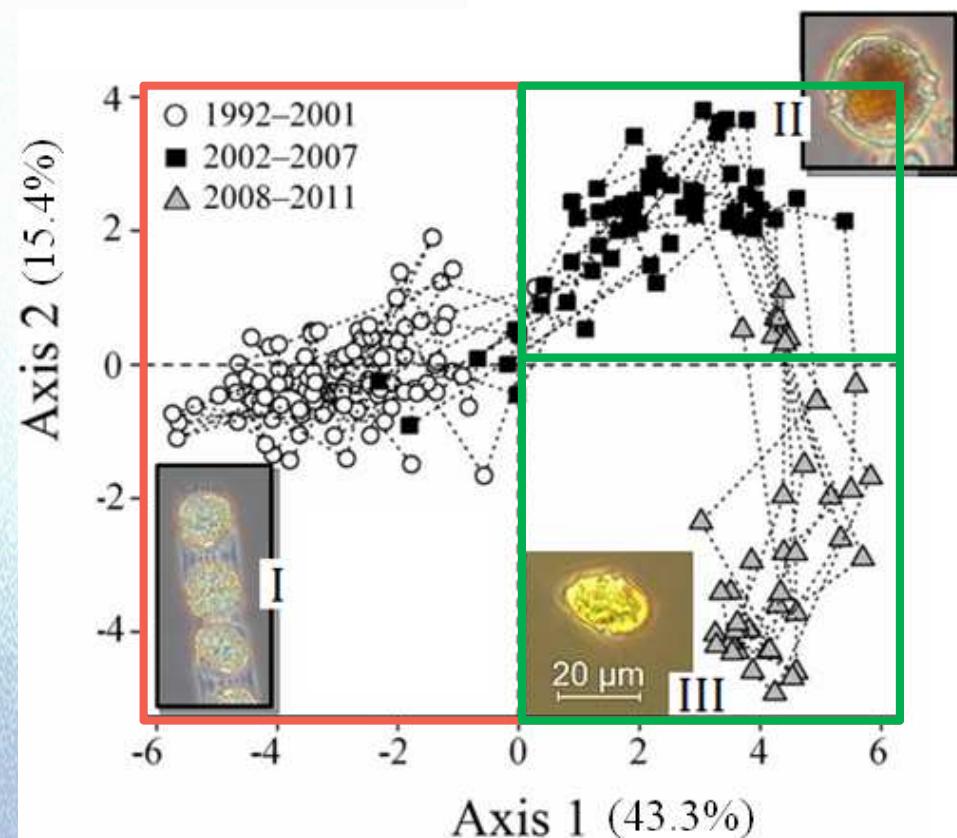
diatoms: *Melosira*
Stephanopyxis

- **Second period (2002 - 2007)**

Increasing dinoflagellates
richness: *Amphidinium*
Alexandrium

- **Third period (2008 - 2011)**

Increasing frequency of
occurrence of some dinoflagellates

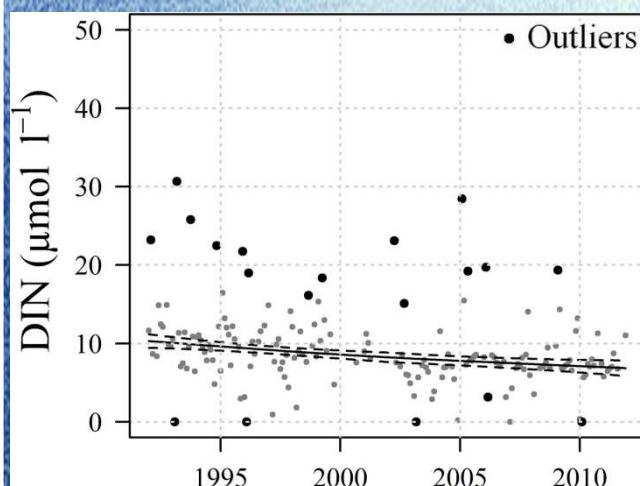


TEMPORAL STRUCTURE REMAINS ALMOST
CONSTANT IN SPACE

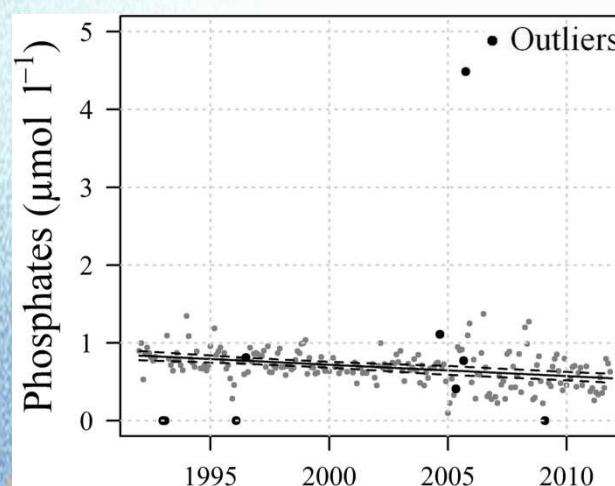
ROLE OF HYDROLOGICAL PARAMETERS AND LARGE-SCALE CLIMATIC VARIABILITY

Observed trends in environmental parameters

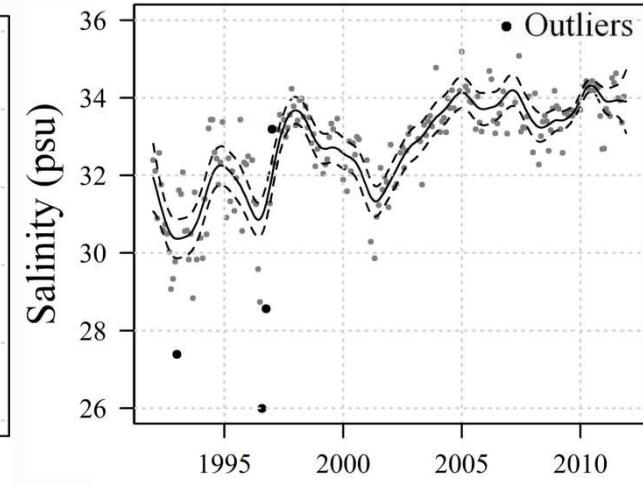
↓ [dissolved inorganic nitrogen]



↓ [phosphates]

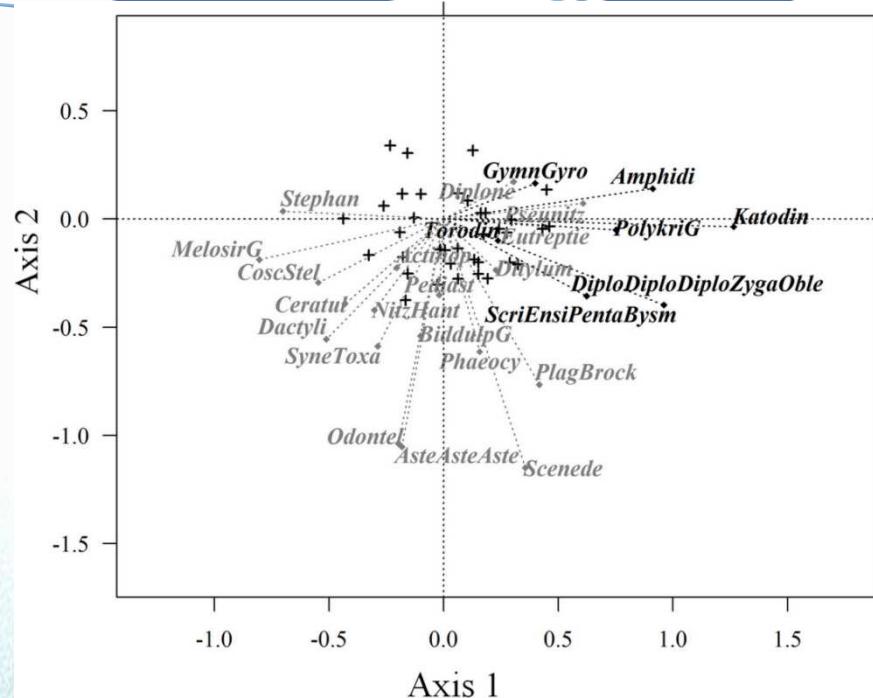
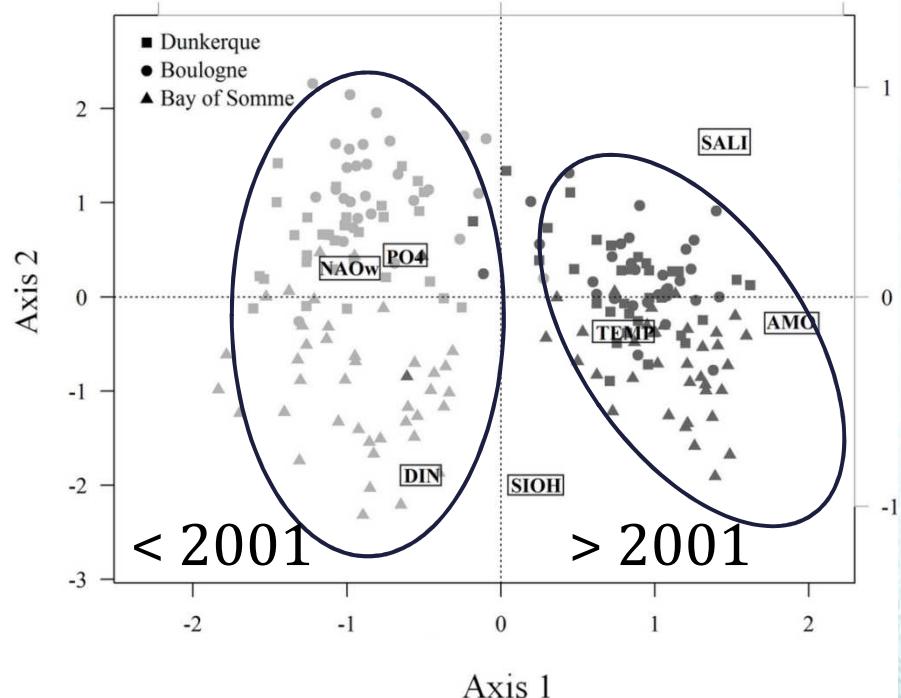


↑ salinity



- No pronounced variations for [silicates]
- Trends were not stable: spatial differences

ROLE OF HYDROLOGICAL PARAMETERS AND VARIABILITY



- First axis describe a temporal structure with two periods
- AMO, salinity: main factors defining the temporal structure

- Dinoflagellates positively associated with AMO, salinity and temperature
- Diatoms association with variables depends on taxonomic units
 - positively related to silicates and DIN
 - some diatoms are positively related to NAO_w or AMO

«top-down»
control

Zooplankton
?

AMO

Diatoms

Dinoflagellates

AMO

Salinity

Nutrients

River flow

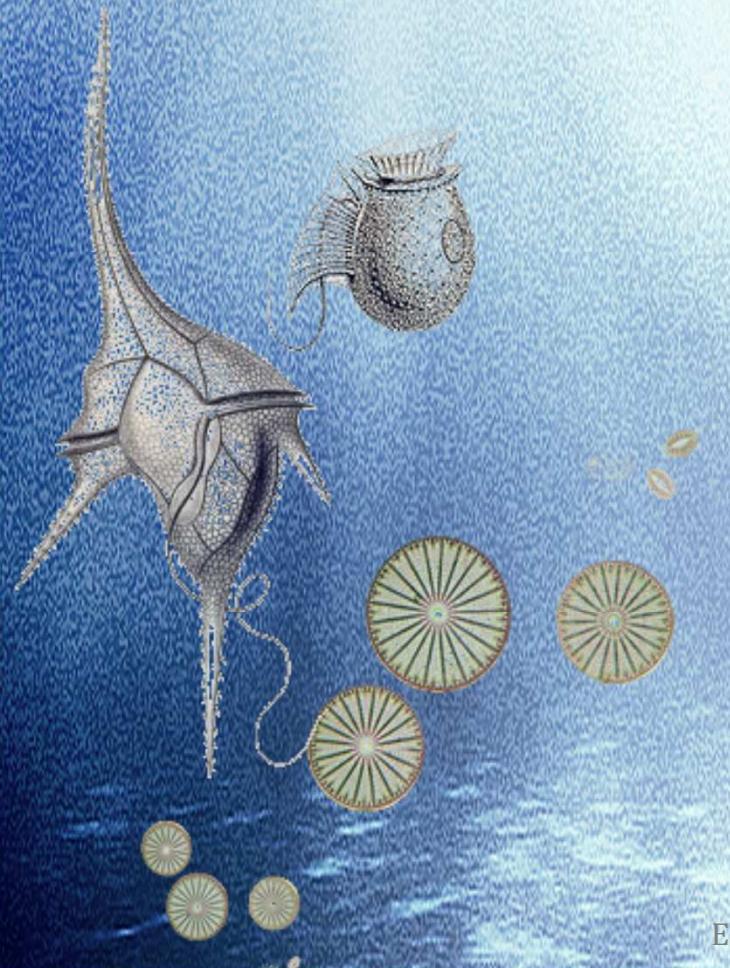
Precipitations

Agriculture practices
Performance of treatment
plants

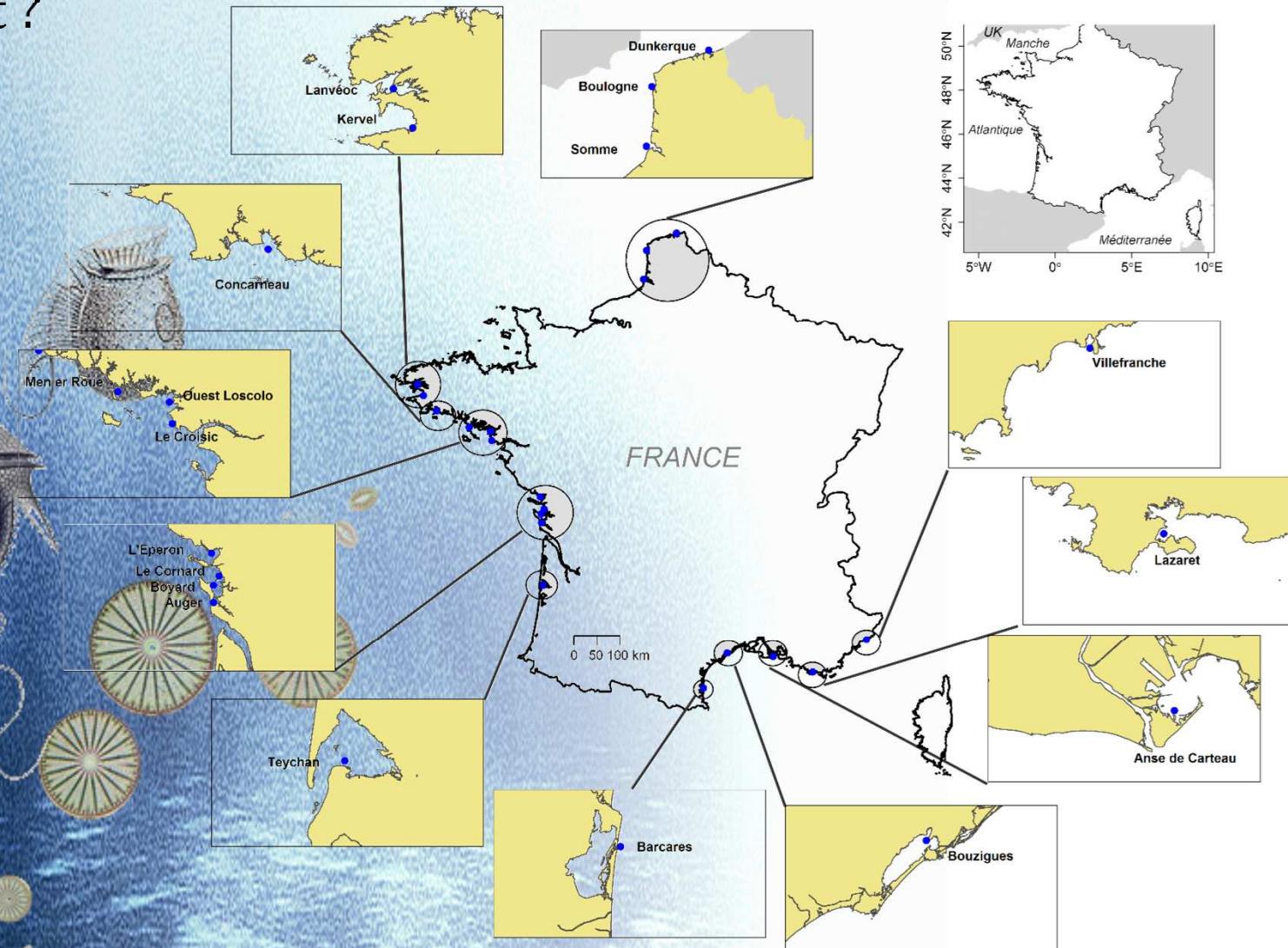
«bottom-up»
control

Goberville *et al.* 2010
Hernández Fariñas *et al.* 2014

Are these changes also observed in other zones of the French coast ?

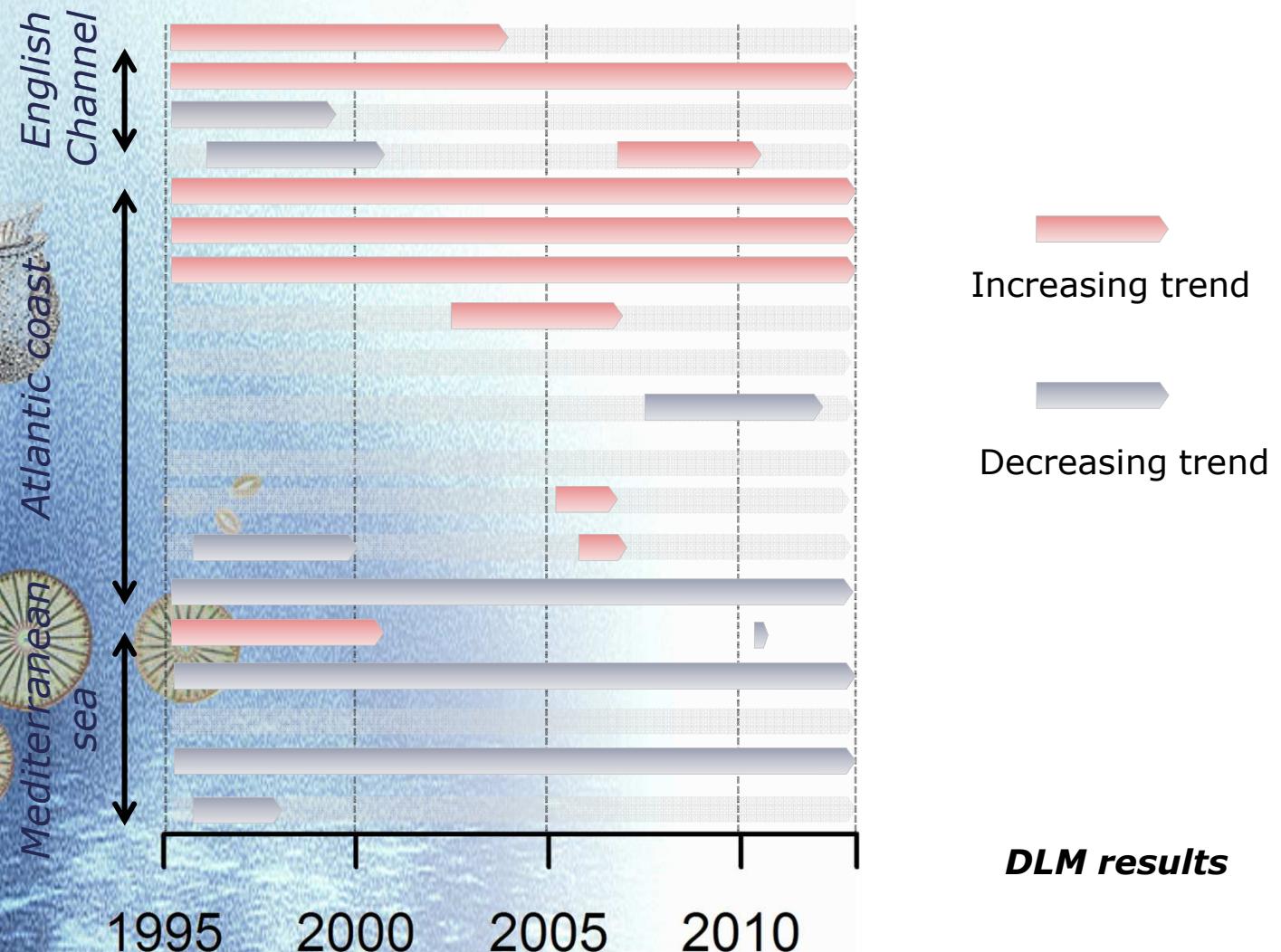


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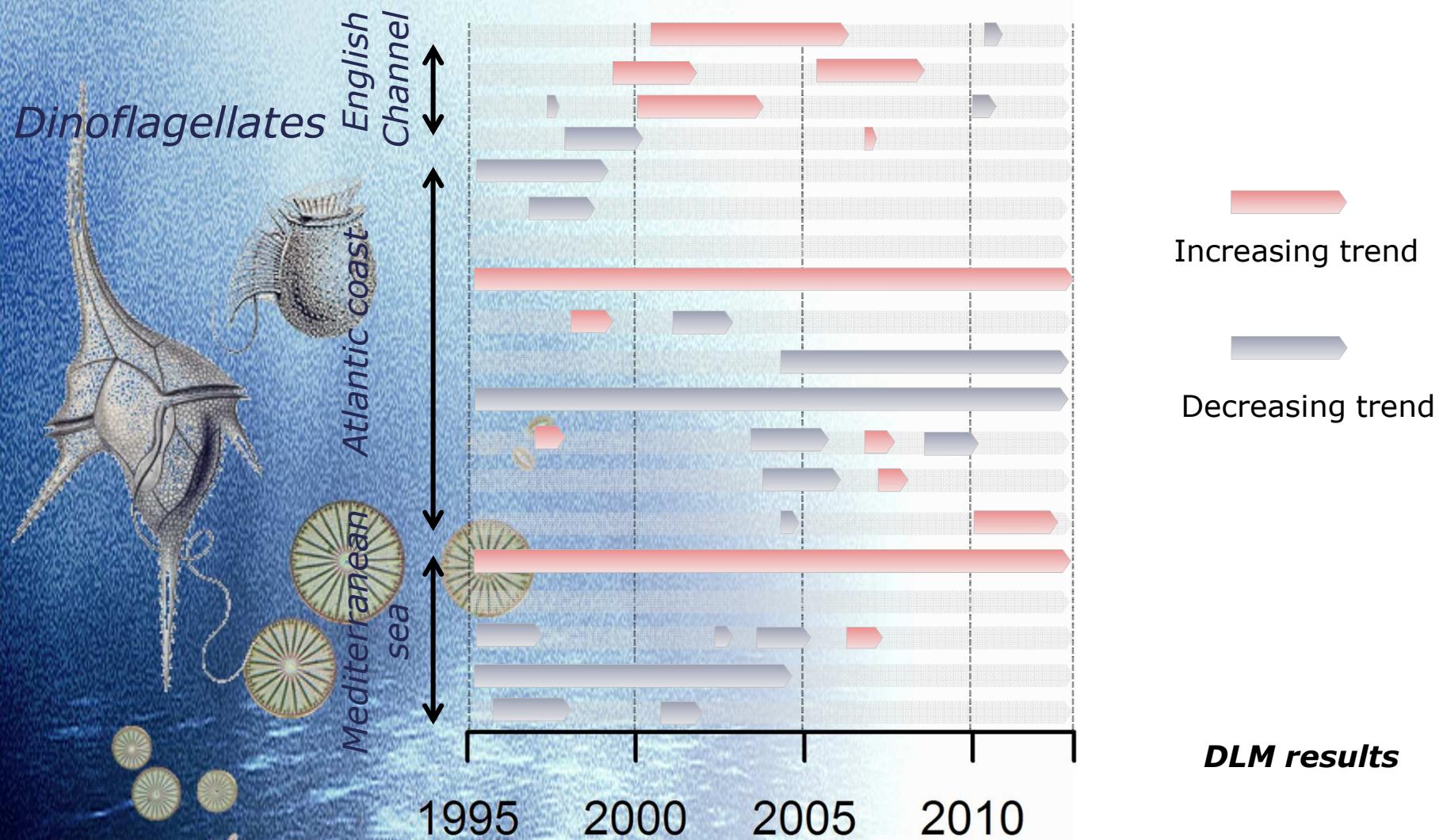


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Diatoms

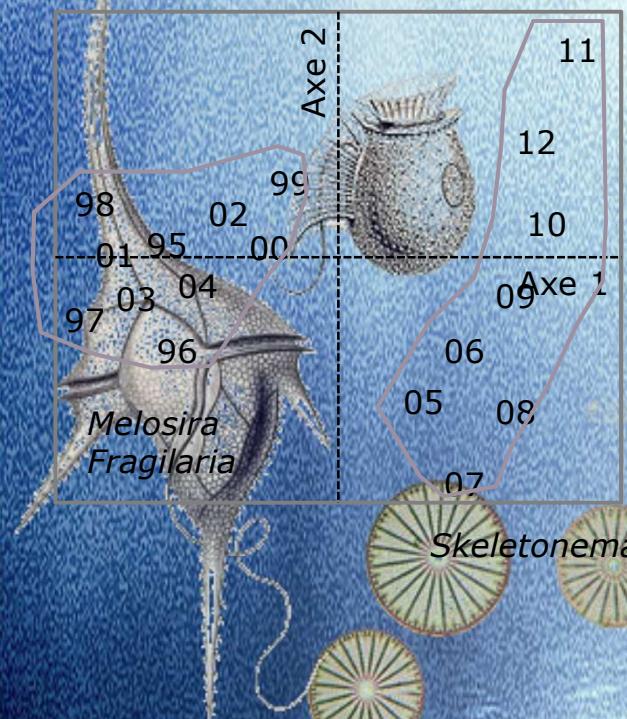


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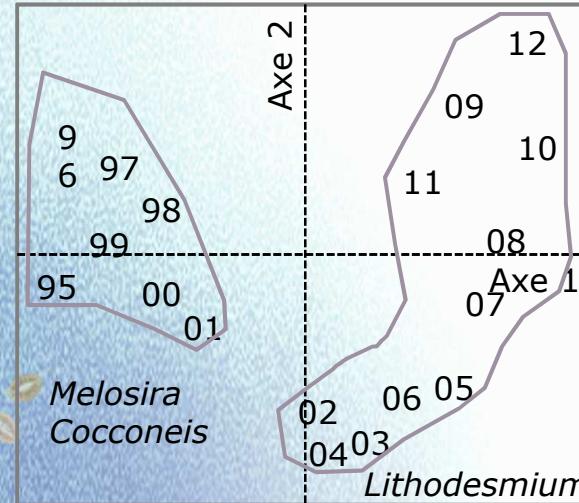


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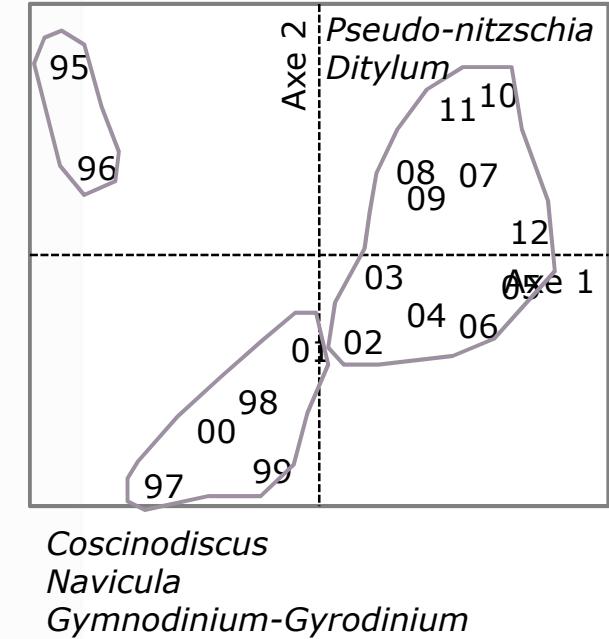
Pertuis-Charentais



Bassin d'Arcachon



Est de la Méditerranée



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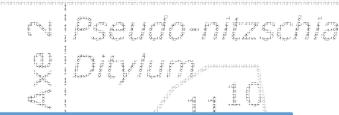
Pertuis-Charentais



Bassin d'Arcachon



Est de la Méditerranée



- Strong spatial heterogeneity in the temporal evolution of phytoplankton communities
- Temporal typologies do not always involve the same taxa, and their temporal evolution can be very different from one area to another

Gymnodinium-Gyrodinium



**THANK YOU
FOR YOUR ATTENTION**