

Northern Hemisphere climate impact on Mediterranean zooplankton

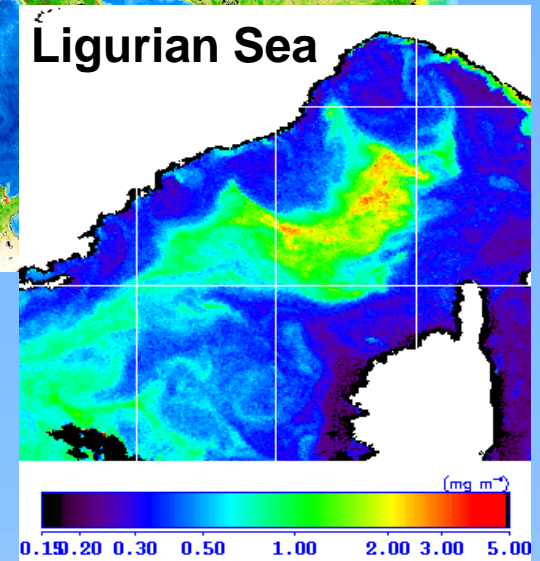
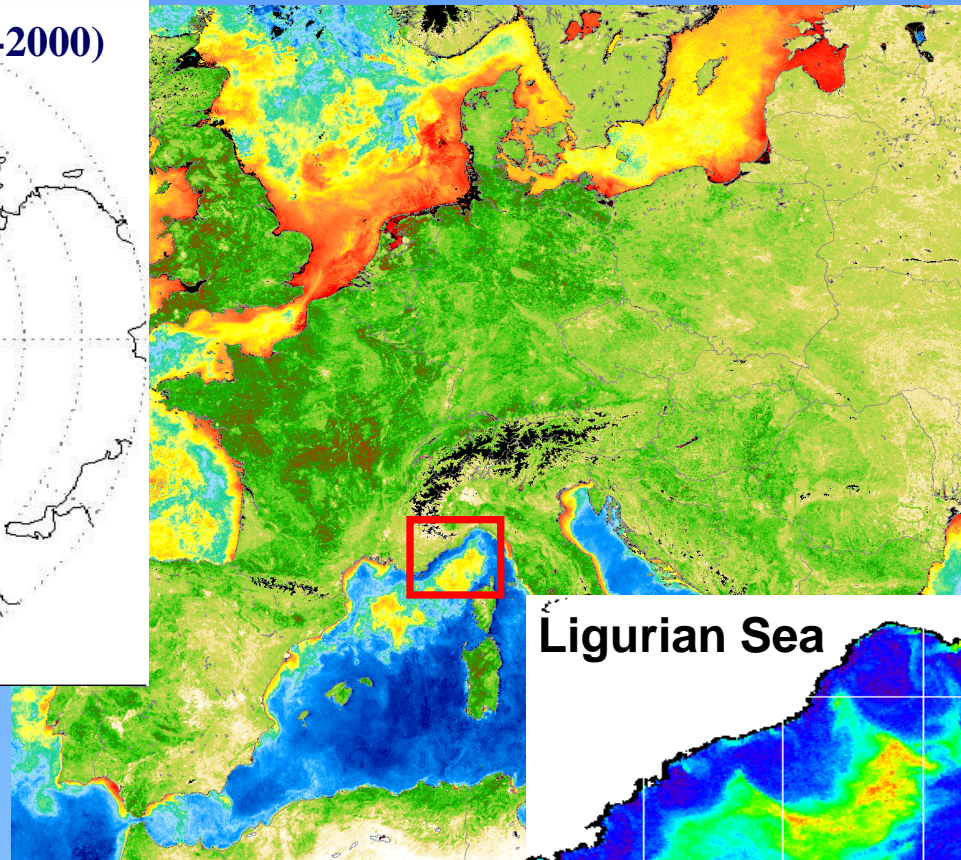
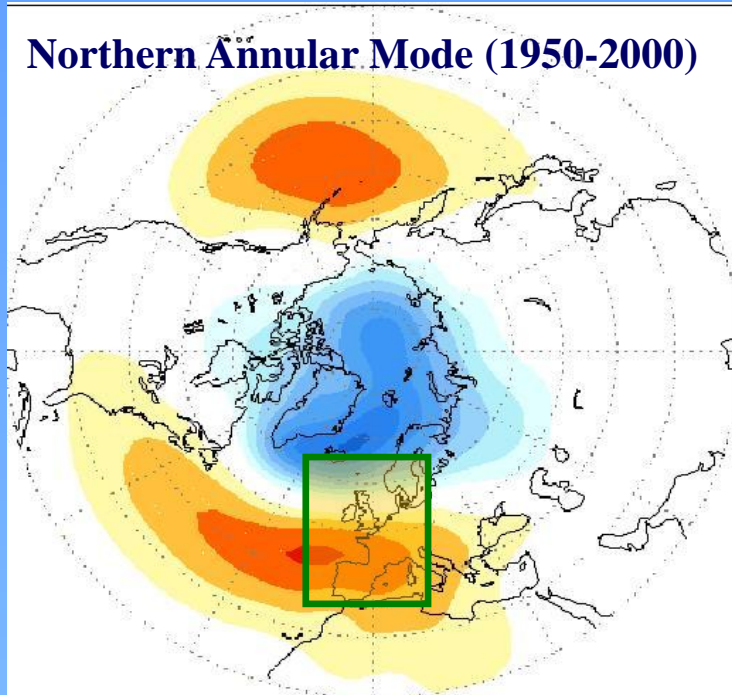
JC Molinero*, F Ibanez, S Souissi, P Licandro,
E Buecher, S Dallot & P Nival

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28 May – 1st June, Hiroshima, Japan



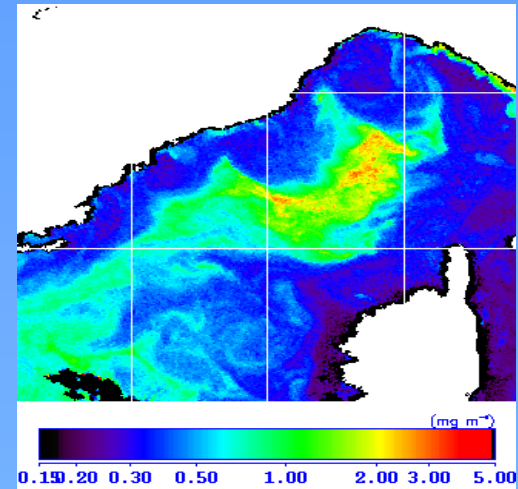
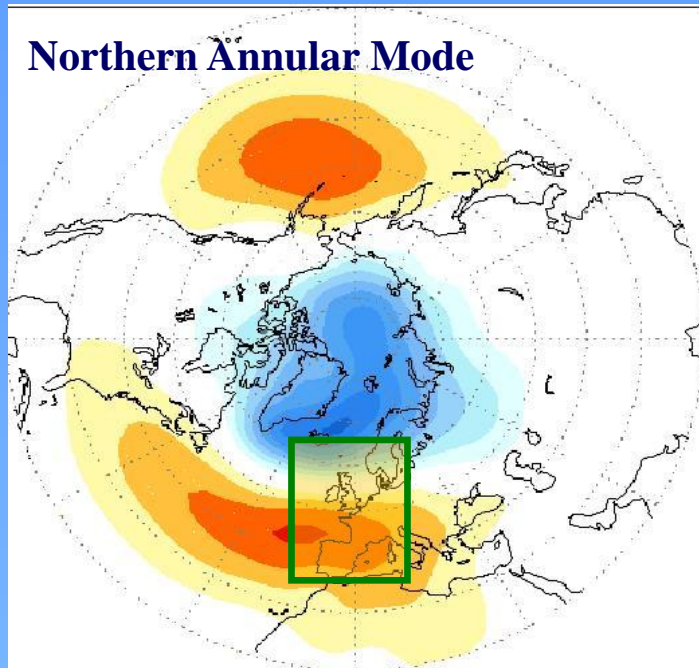
Study site



→ One of the more productive areas in the western Mediterranean basin

→ Highly sensitive to large scale atmospheric forcing

Data & scales (1950 – 2000)



proxy of the Ligurian climate
(6°E – 10°E; 42°N – 44°N)

NAO/AO

Northern Hemisphere temperature

East Atlantic Pattern

East Atlantic Western Russia pattern

**Large
scale**

Parameters: atm. pressure, air temperature,
irradiance, precipitation, geopotential height 500mb
(Reanalysis data set, 1950-2005)

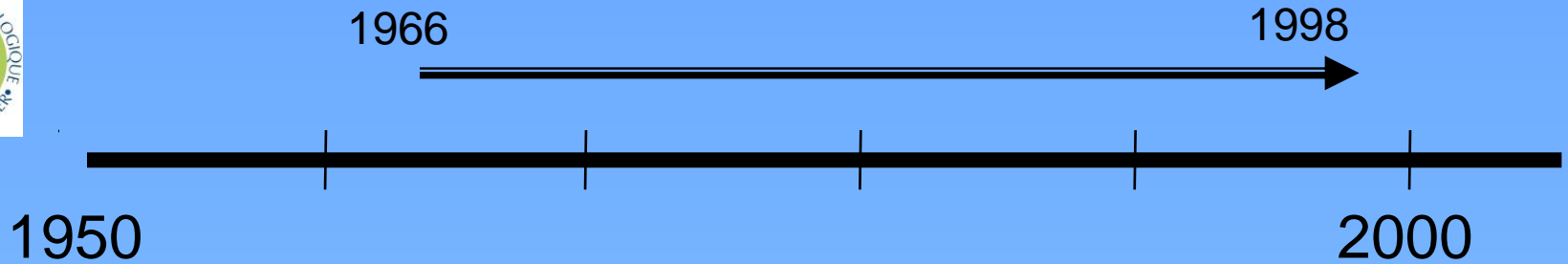
**Regional
Scale**

(Ligurian basin)

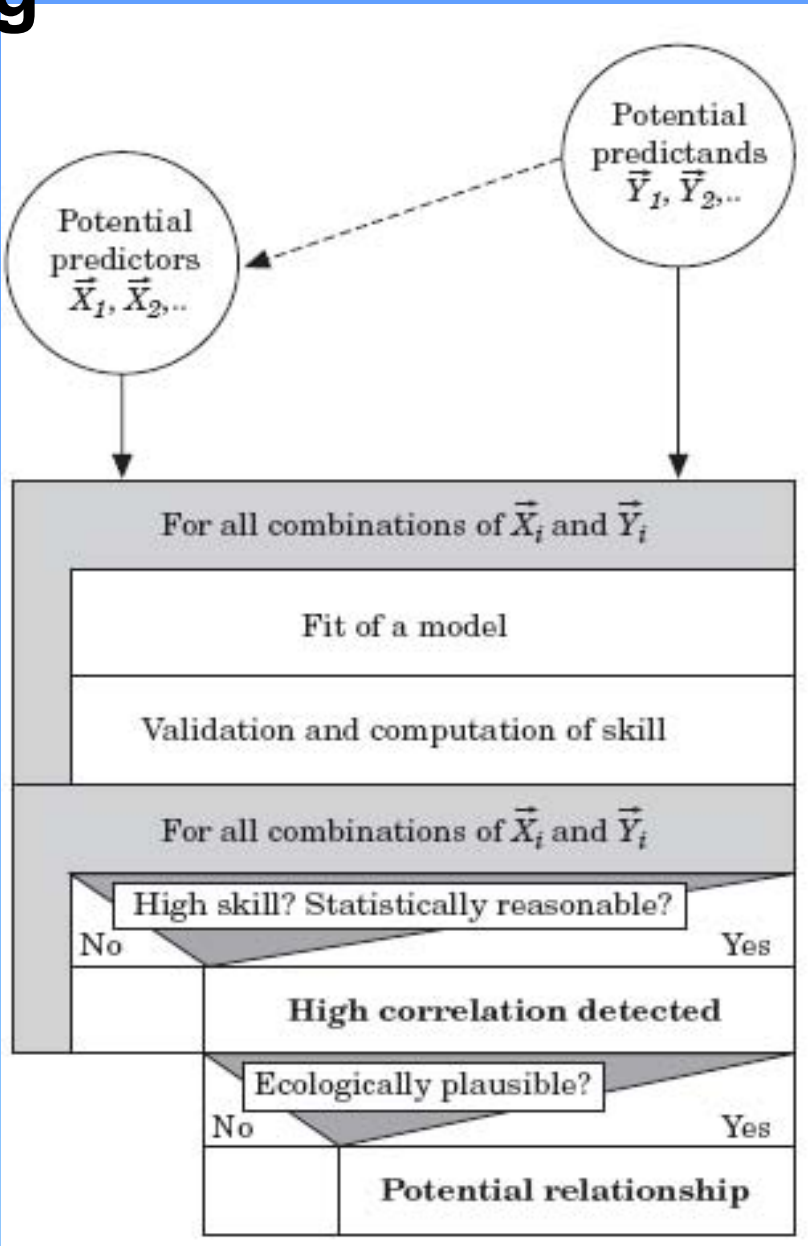
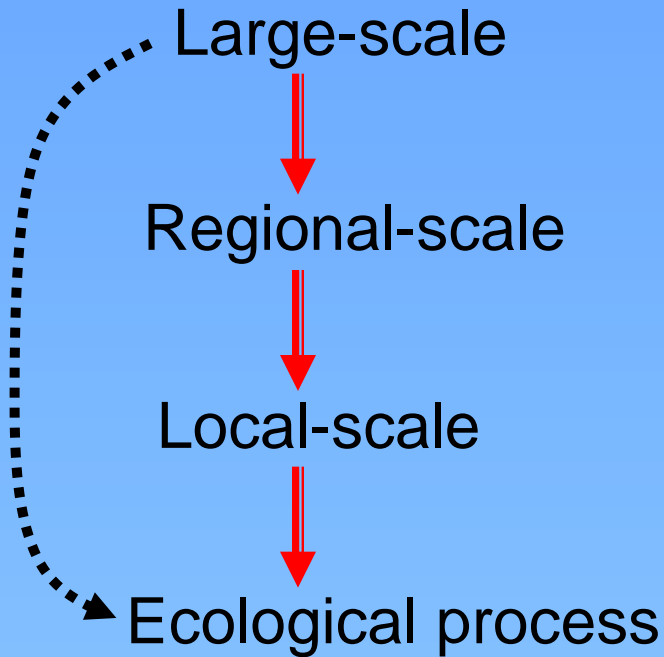
Local scale

Water temperature (1, 20, 50, 75 m depth)

Plankton records (copepods, chaetognaths, jellyfish, salps)



Statistical Downscaling

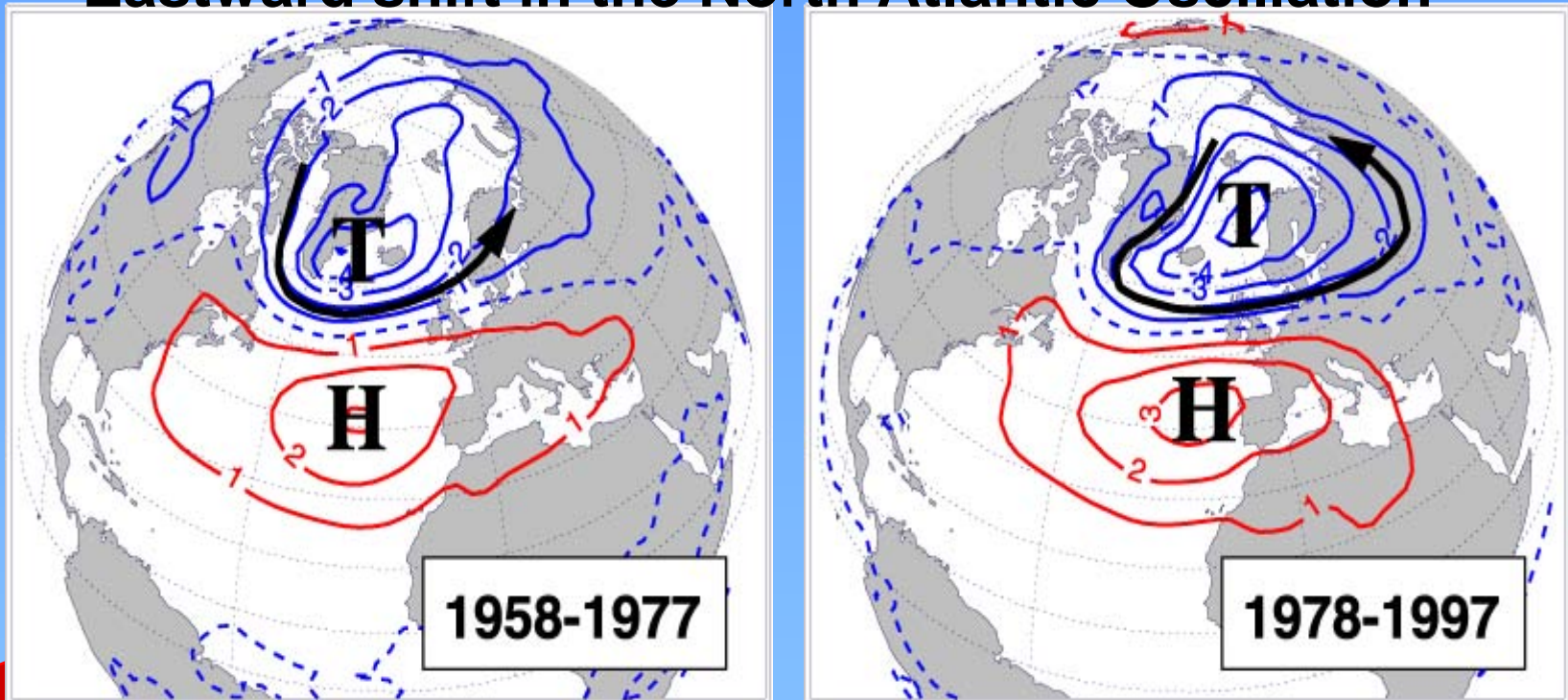


von Storch et al.1993
Dippner et al. 2001

Climate and hydrological patterns

Changes in climate phenomena and consequences on regional atmospheric fields

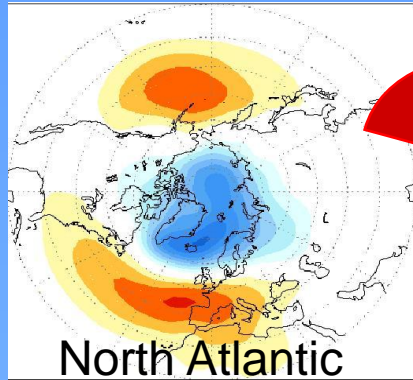
Eastward shift in the North Atlantic Oscillation



From Hilmer & Jung 2000, GRL

Changes in the strength of atmospheric fluxes into Western Europe and the Mediterranean Sea

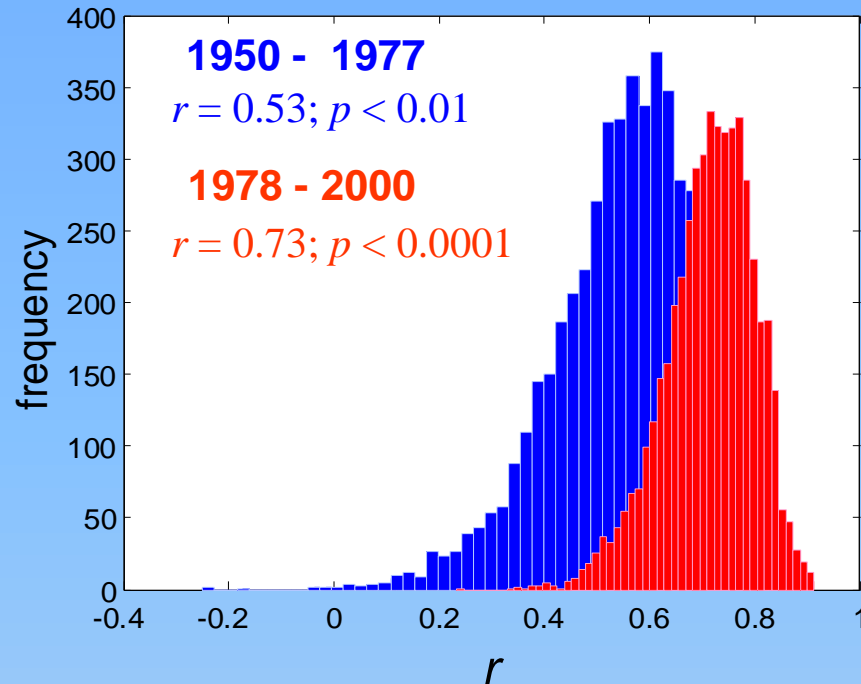
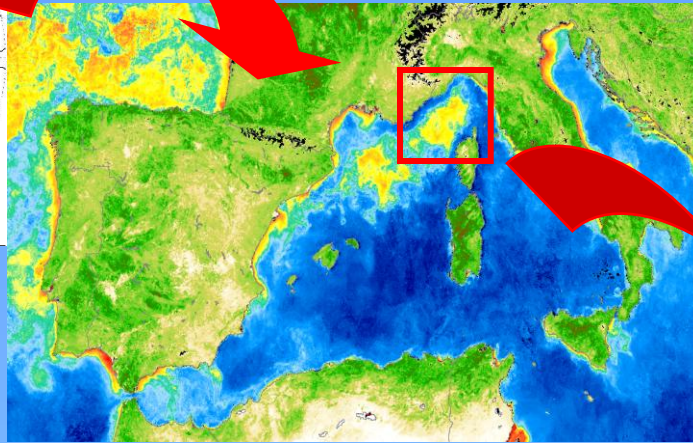
Links between climate proxies at large- and regional scale



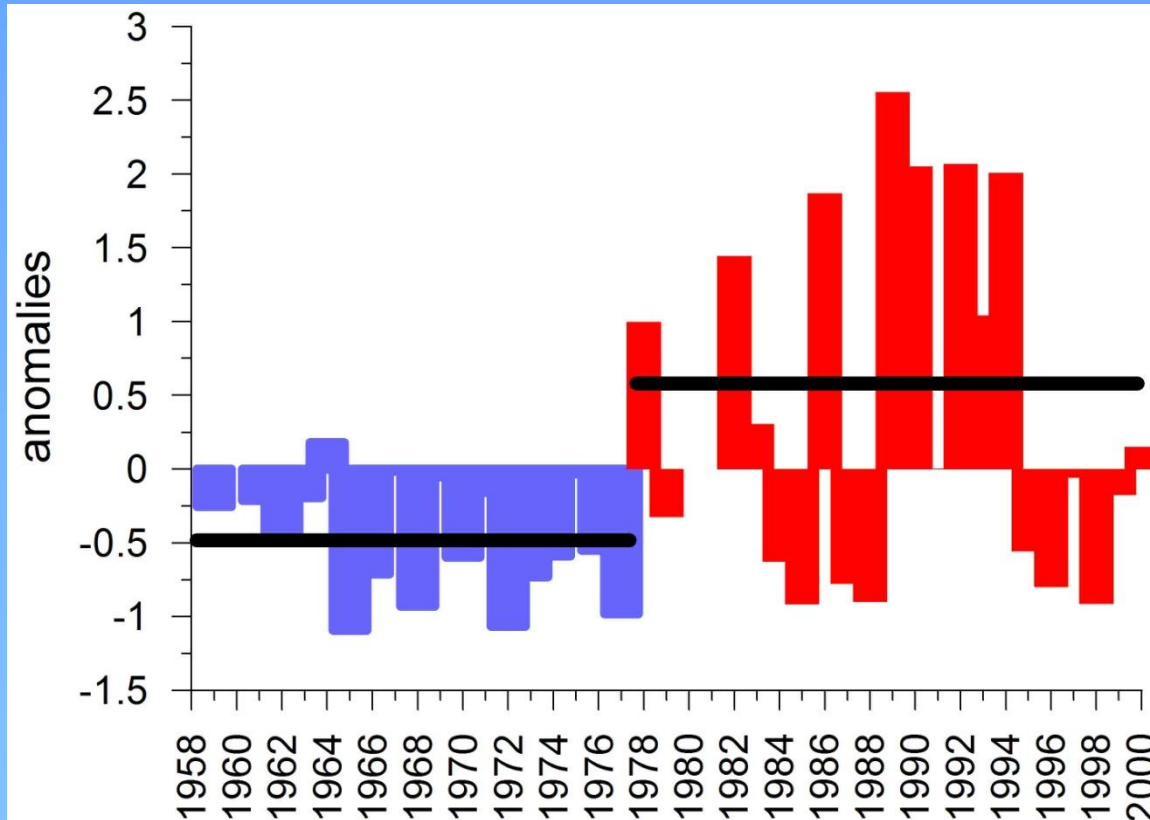
North Atlantic
Climate proxy

NA climate – Ligurian climate (1950 – 2000)

$$r = 0.75; p < 0.001$$

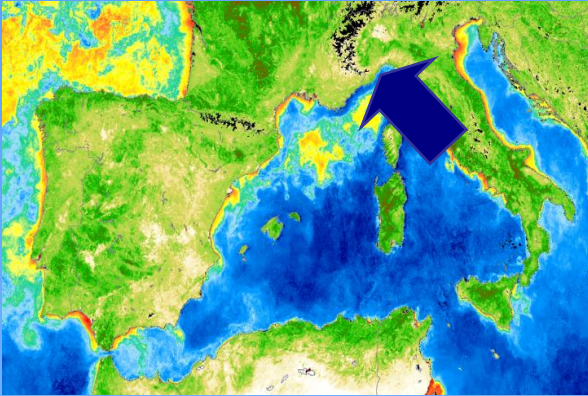


Long-term changes of threshold* values of North Atlantic climate

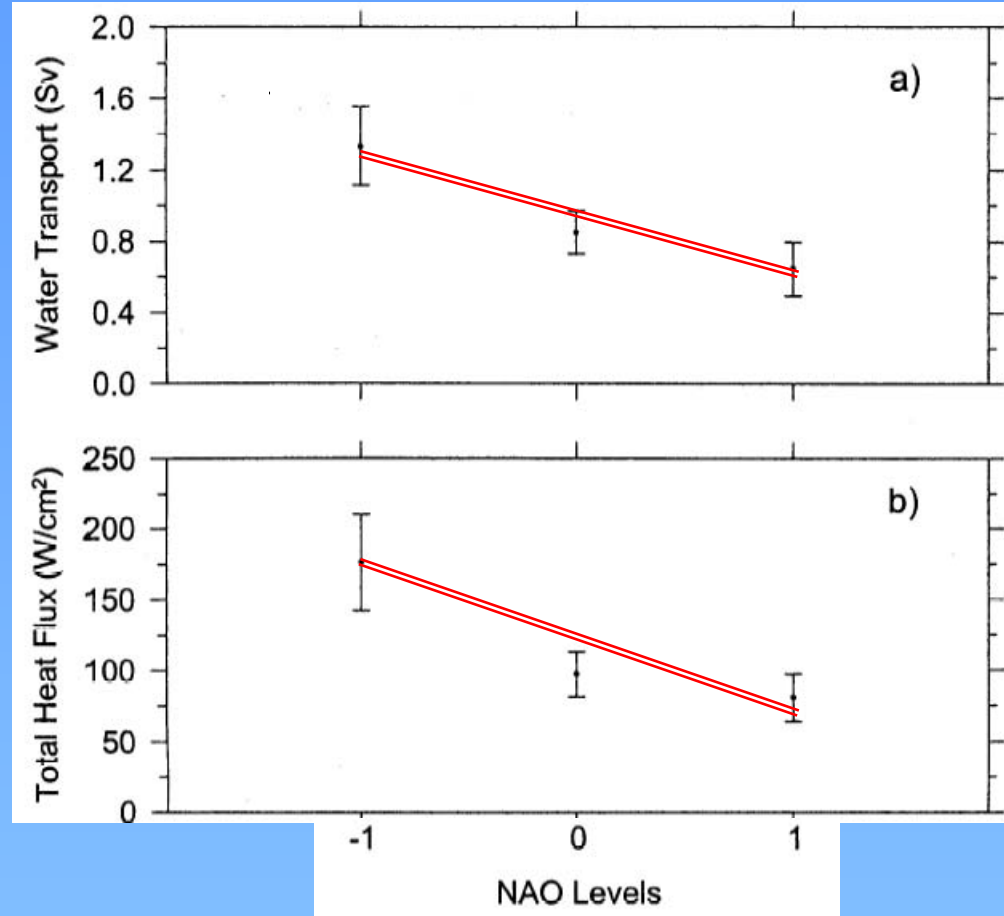


***Values higher than 1 std deviation of the long-term mean of the North Atlantic climate**

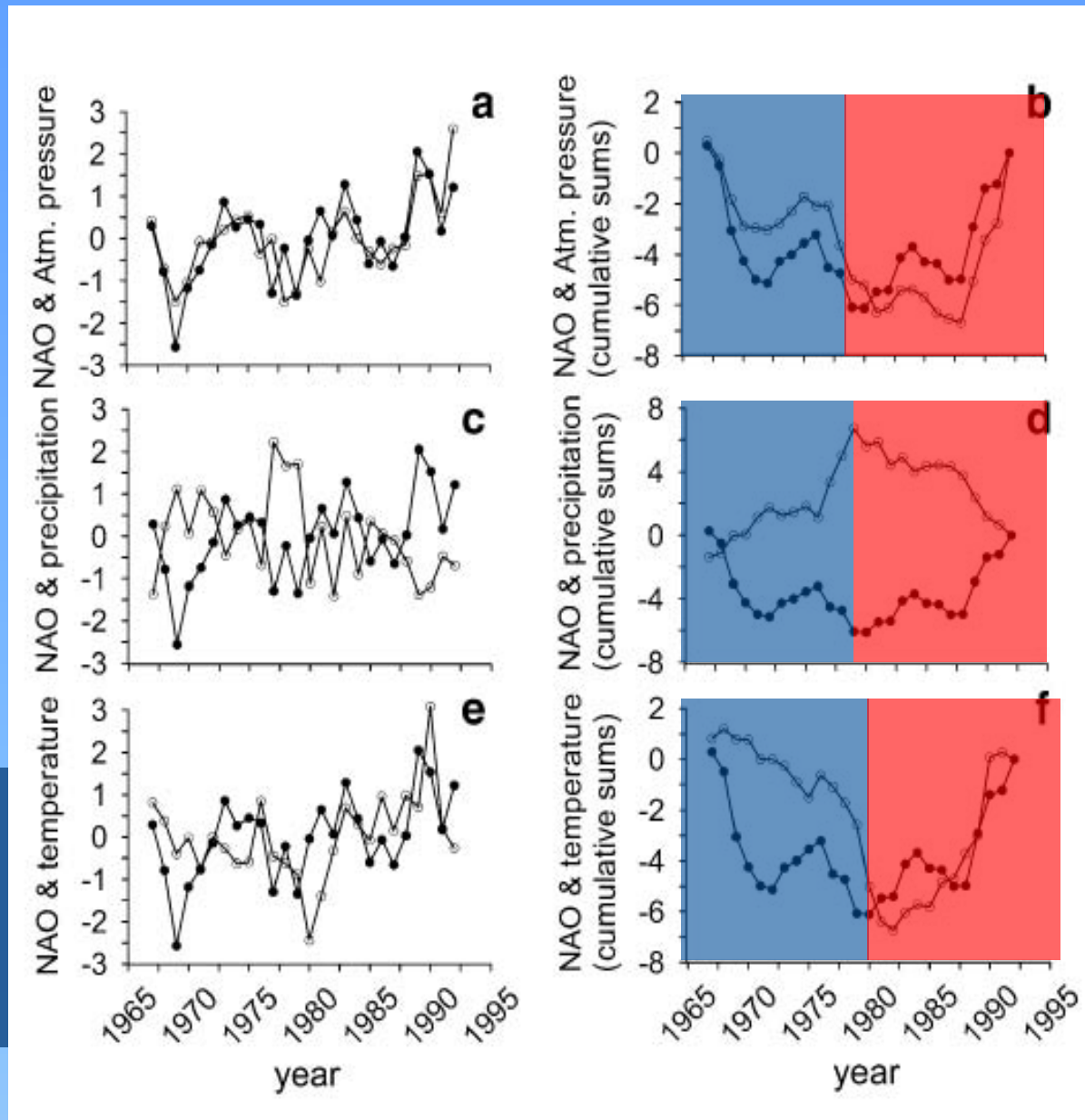
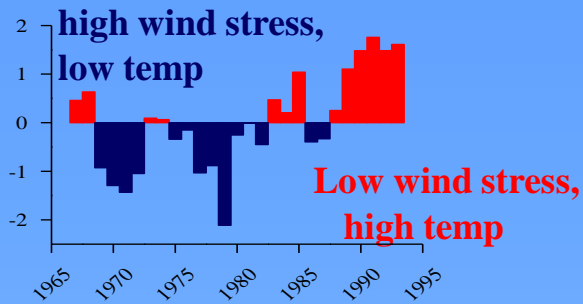
Ligurian Sea



NAO phase positive
NAO phase negative

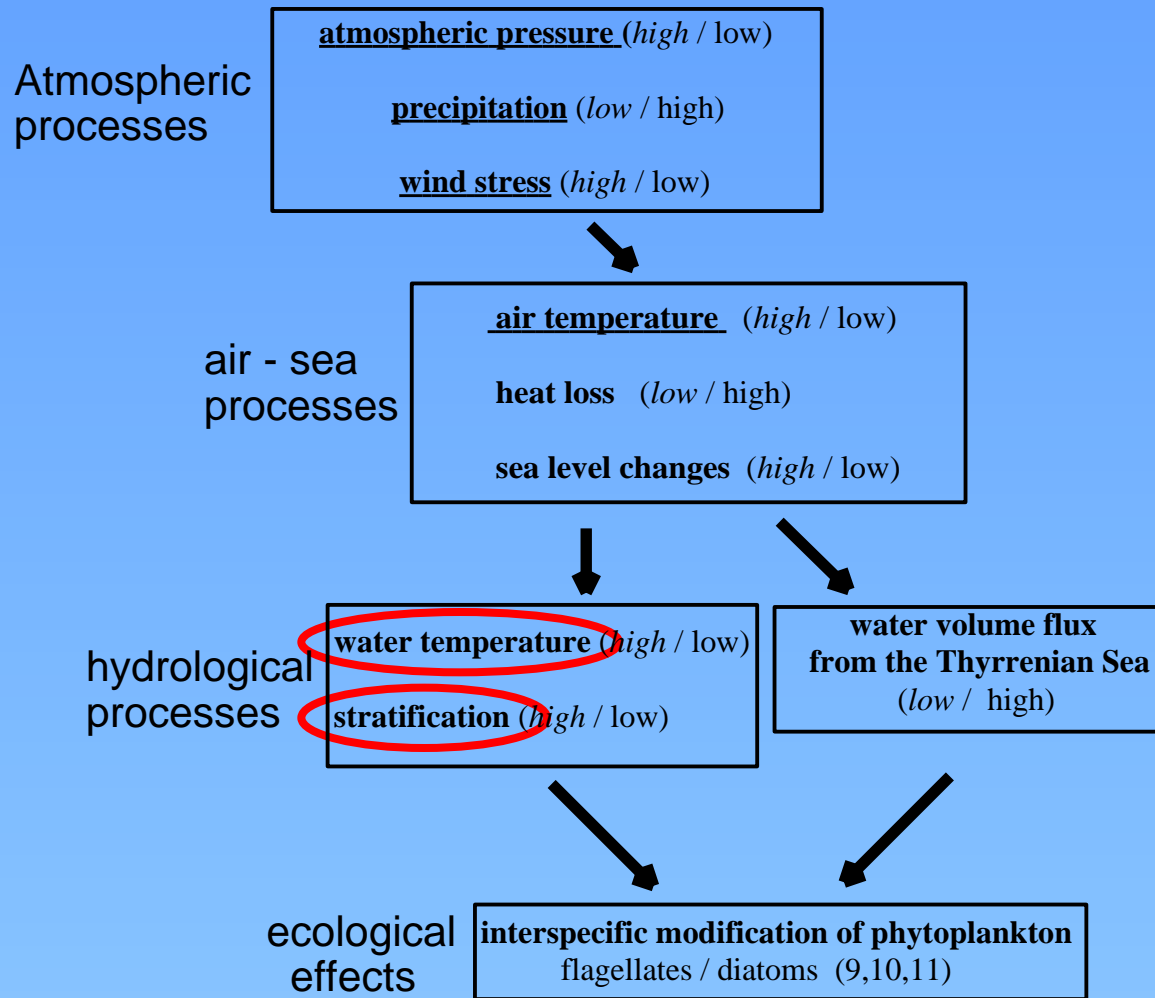


Variability of hydrological conditions



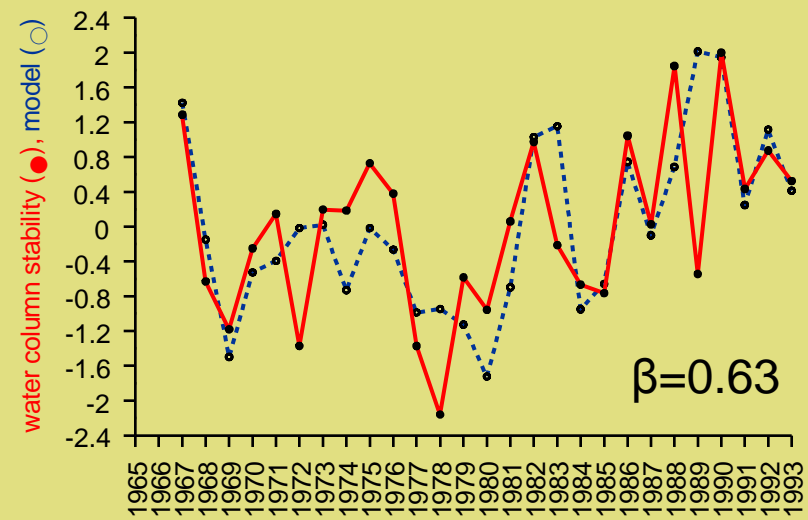
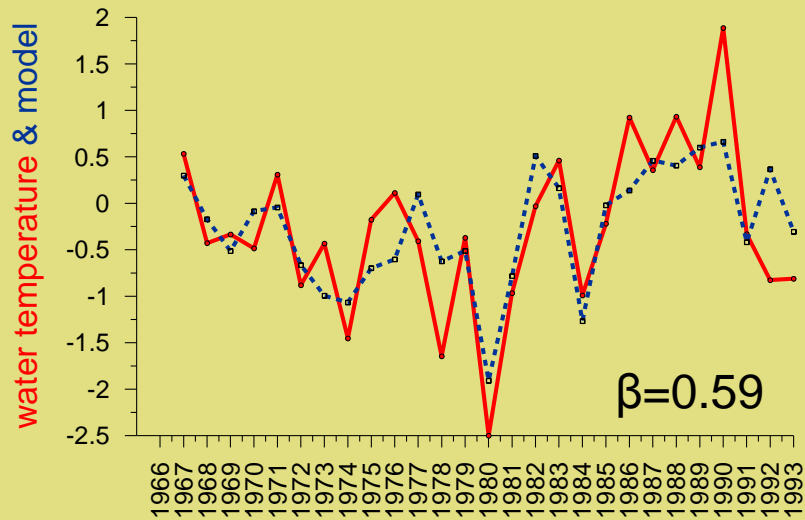
Modifications in the features of the water column & likely on mesoscale hydrographic features

North Atlantic - NW Mediterranean: Mediator factors



North Atlantic - NW Mediterranean: Mediator factors

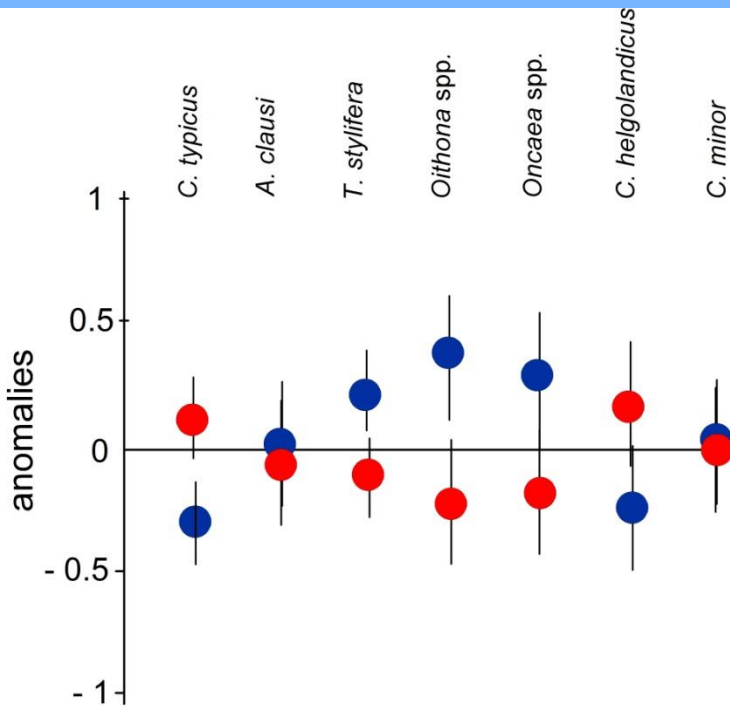
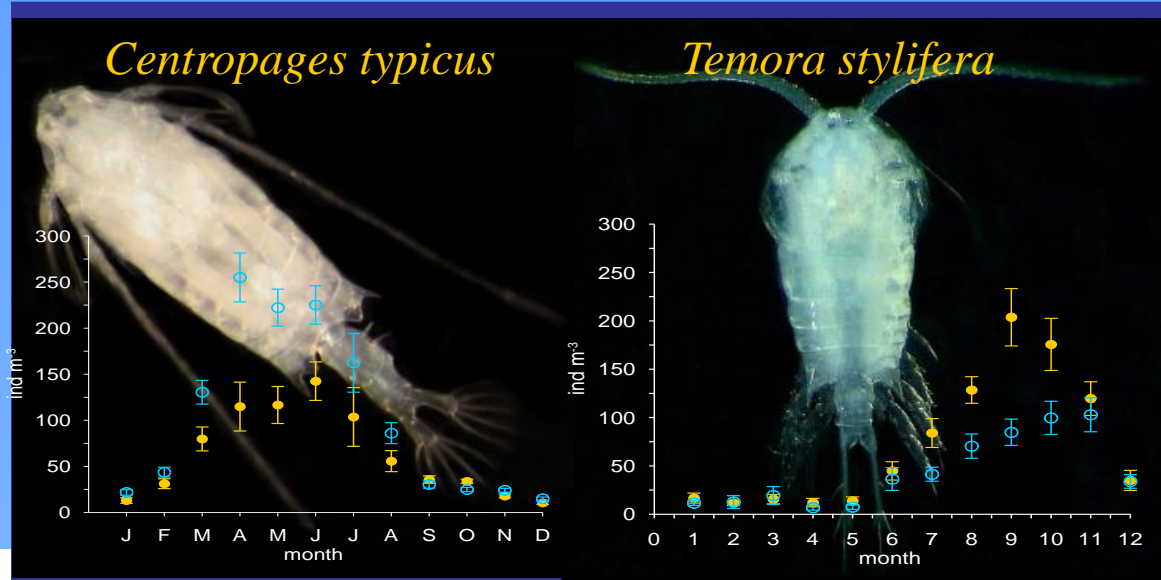
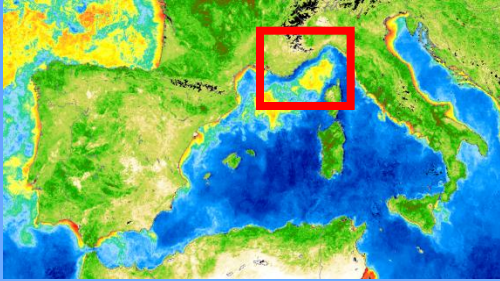
a substantial amount of the variability of water temperature and water column stratification is associated to the NA climate forcing



Interspecific modifications in the phytoplankton compartment

Ecological effects

Ecological effects: phenology of pelagic copepods

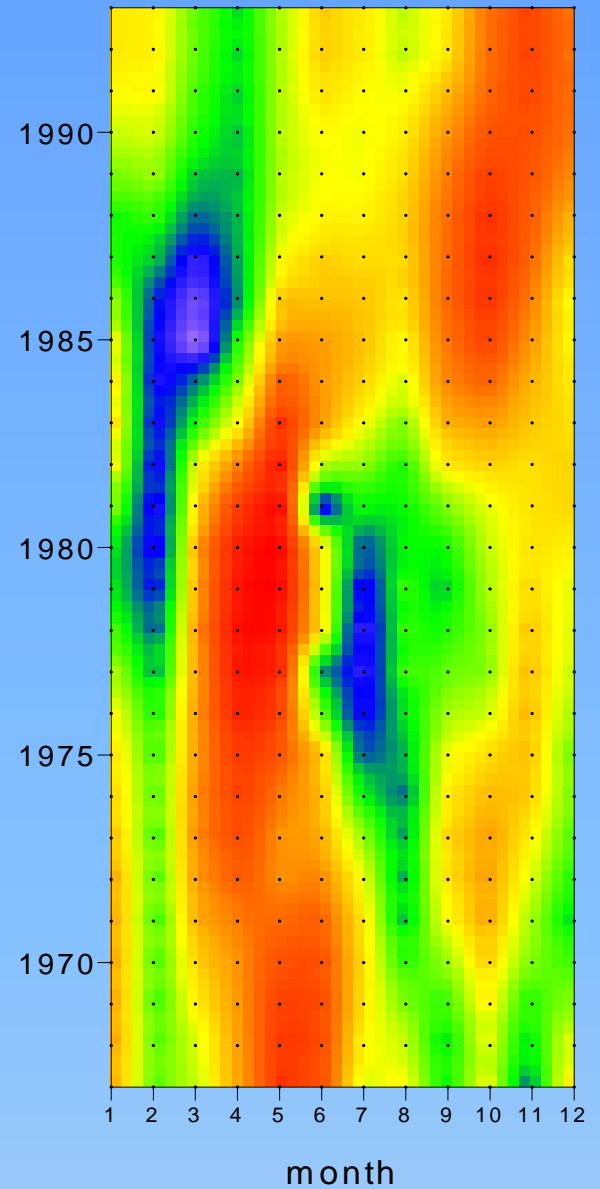
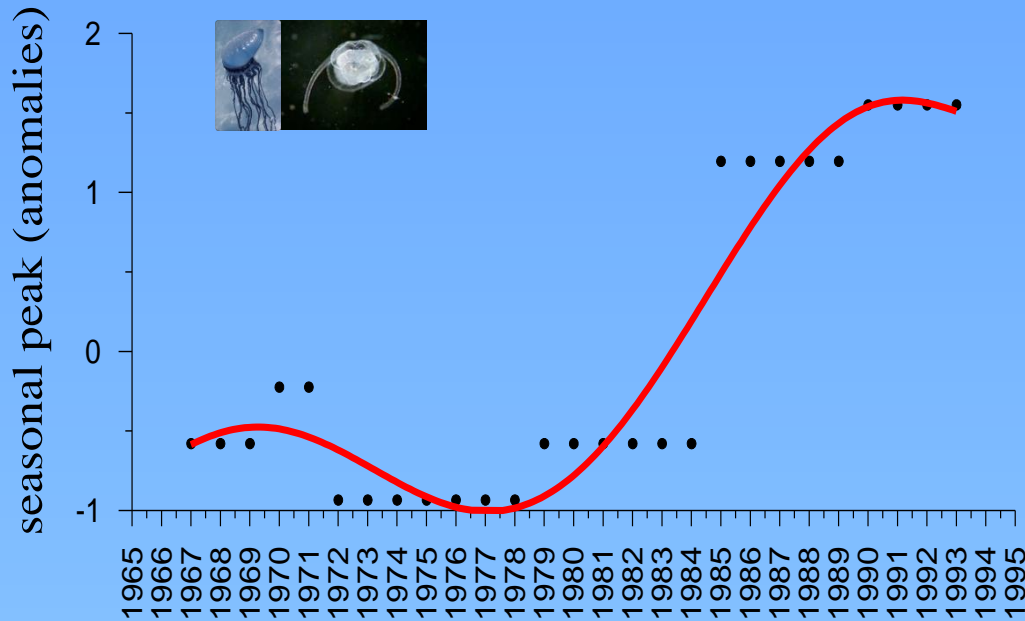
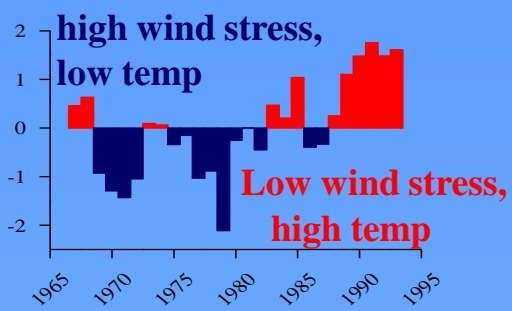


NA climate positive
NA climate negative

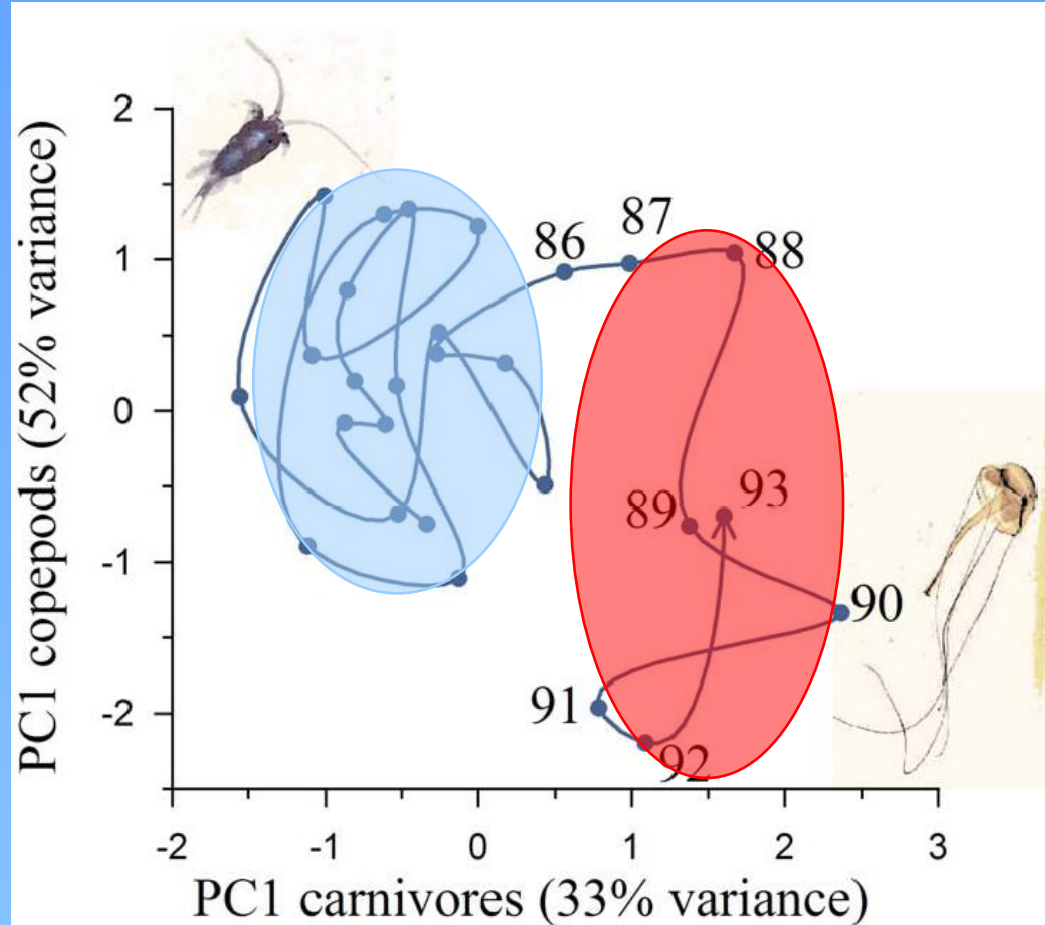
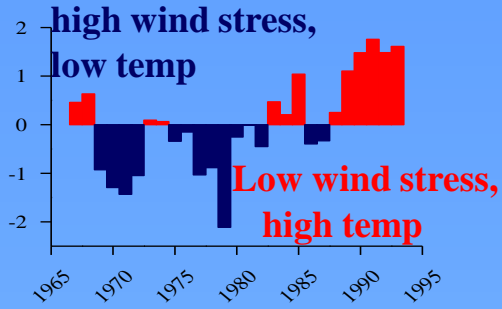
Positive values of NA climate

Negative values of NA climate

Ecological effects: phenology and outbreaks of gelatinous carnivores



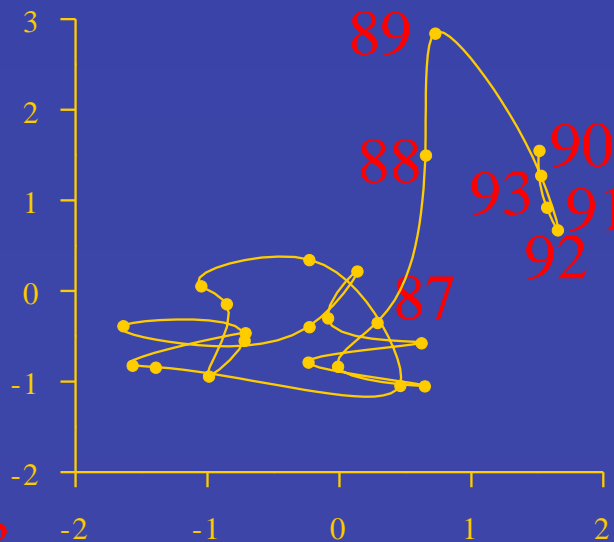
Long-term variability of ecological interactions



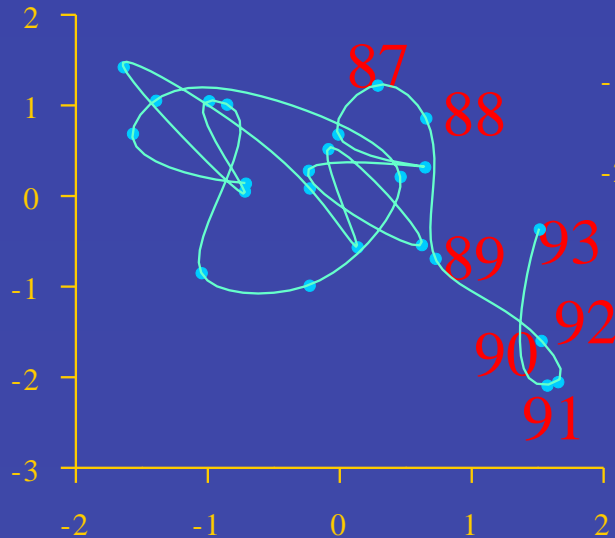
Climate and planktonic trophic levels



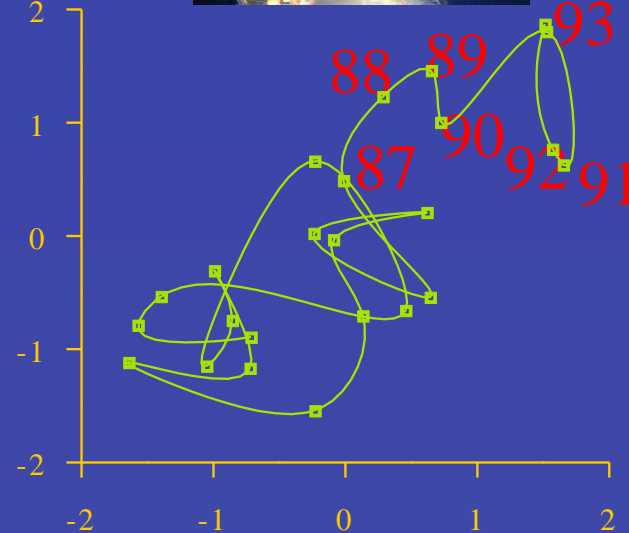
PC1



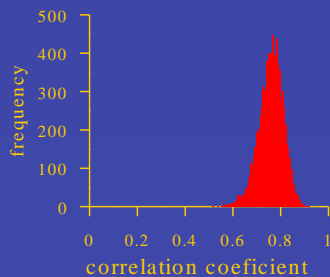
PC1



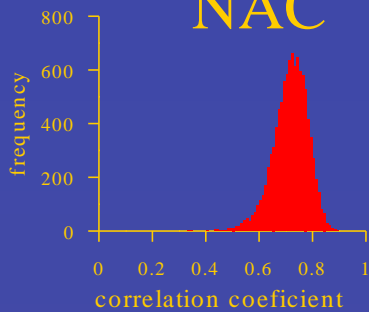
PC1



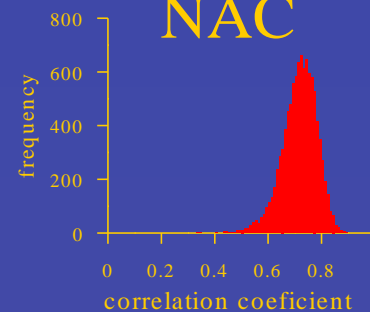
NAC



NAC

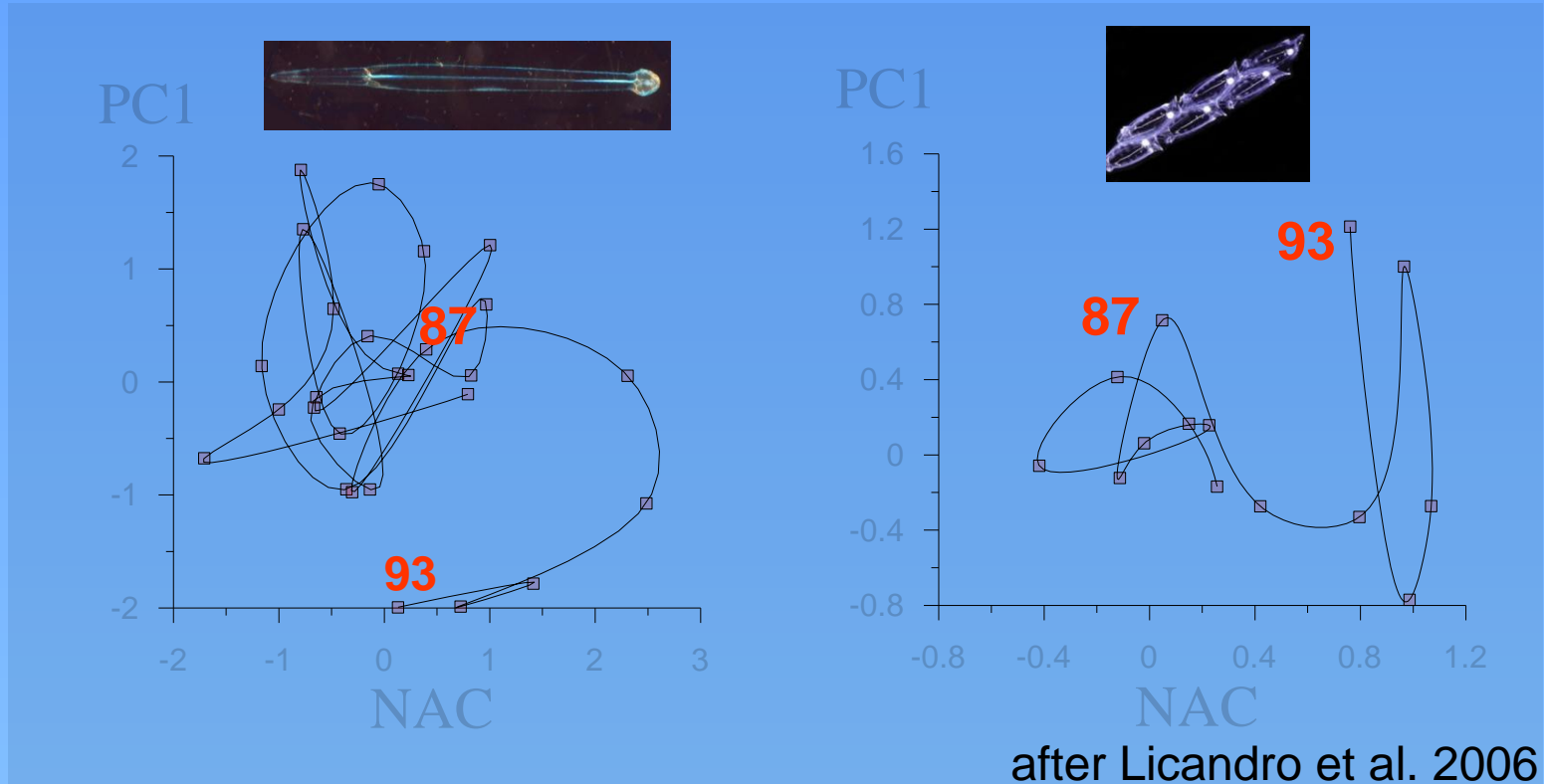


NAC

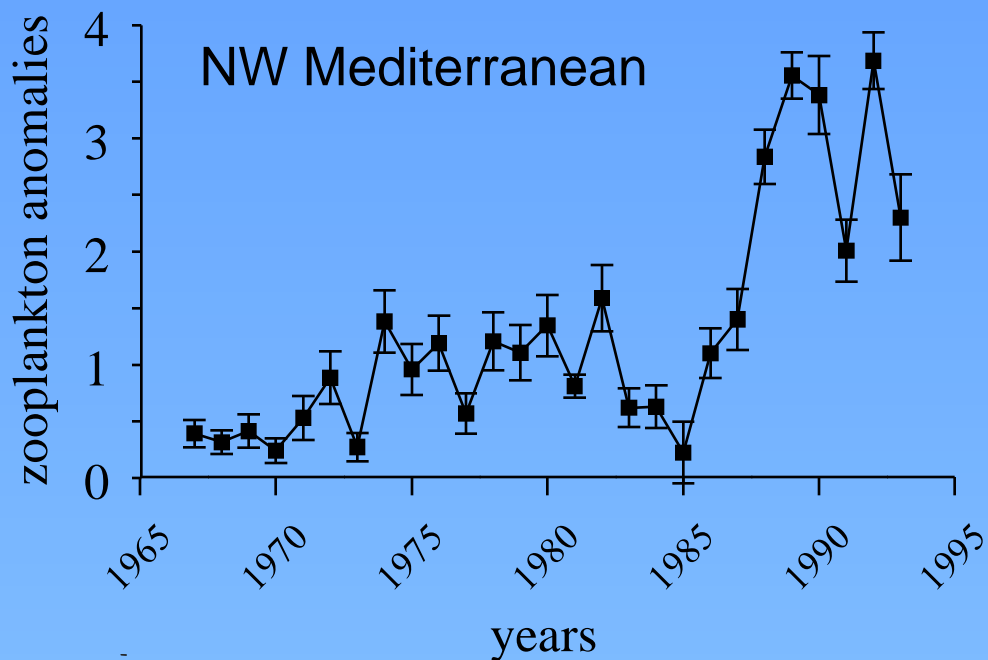


Molinero et al. (in prep.)

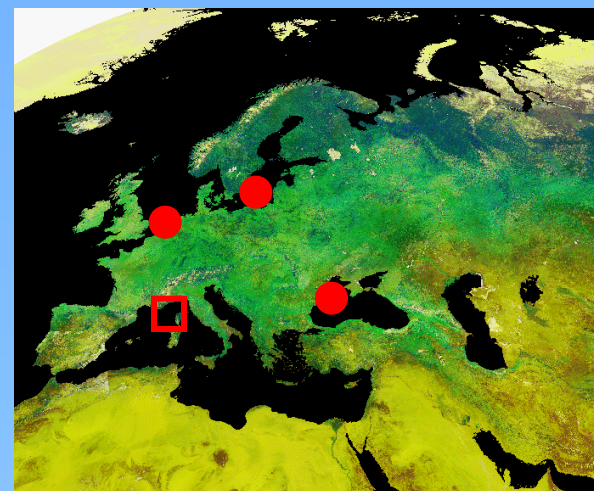
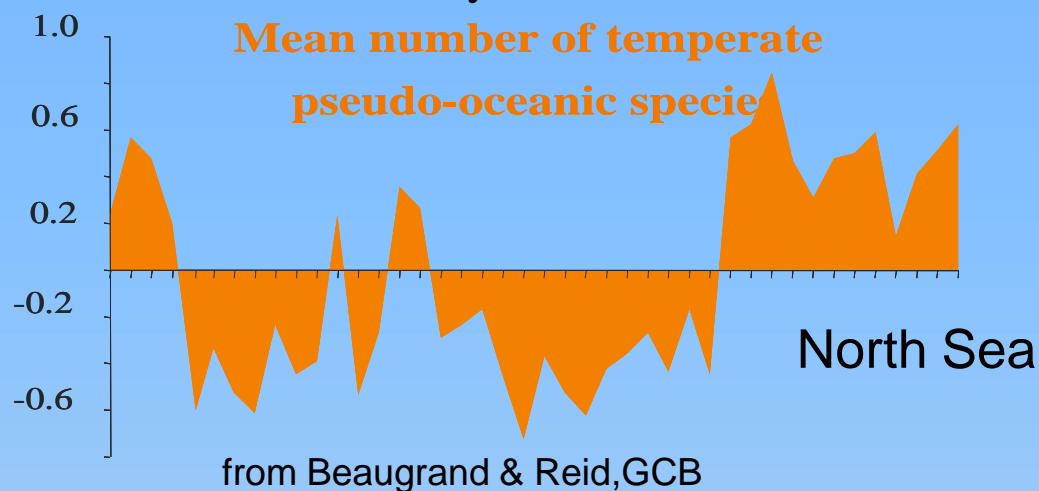
Climate and planktonic trophic levels



As a result of the changes in the Northern Hemisphere climate zooplankton interactions were modified and lead to a **major change in the ecological system of the NW Mediterranean**

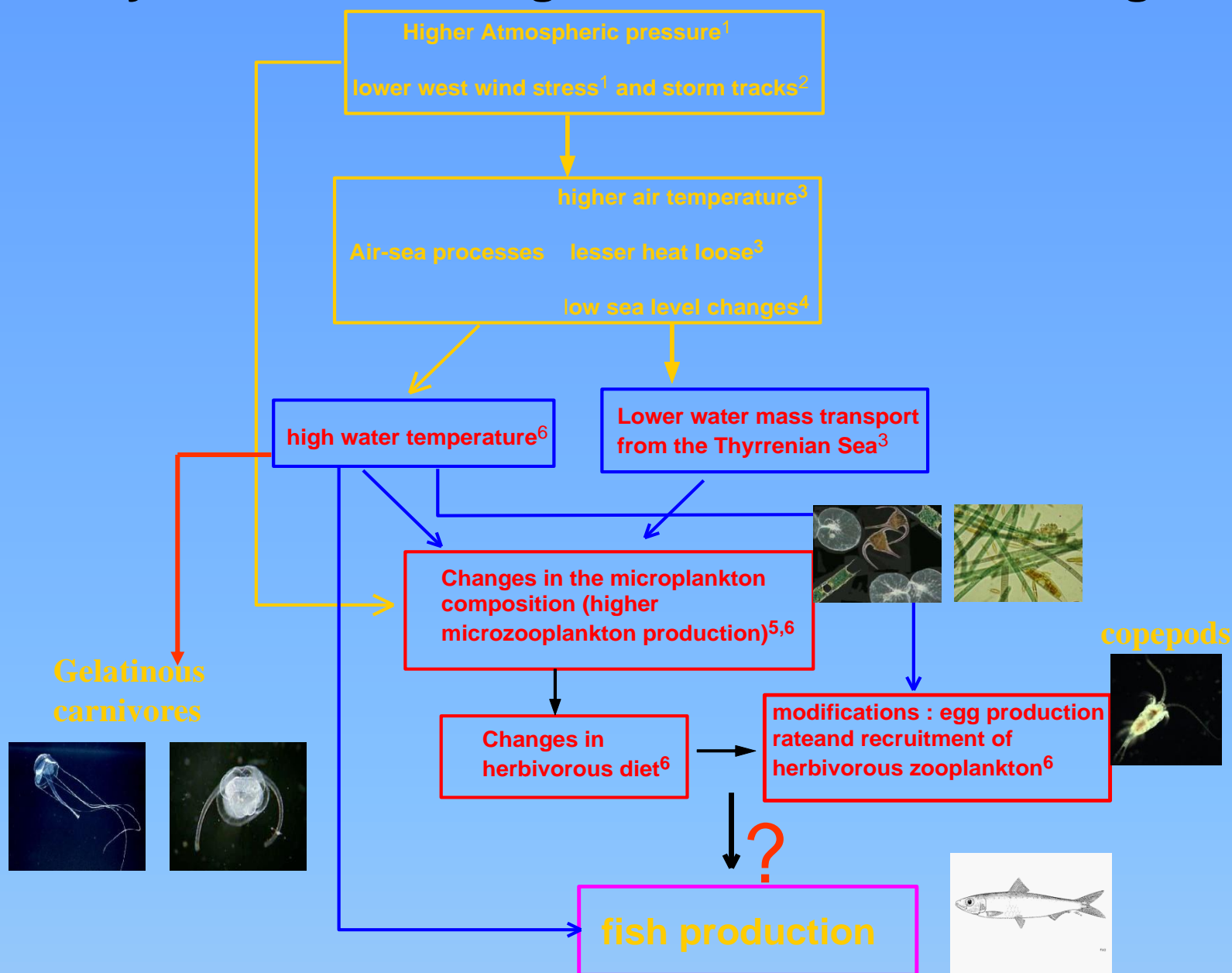


but also in the Baltic, Wadden, and Black Seas



Molinero et al., GCB, in press

An empirical model linking NH climate forcing and plankton dynamics in the Ligurian Sea starts to emerge



Concluding remarks

- A chain of events linking climate and zooplankton variability in the NW Mediterranean was identified. **Climate forcing** has likely altered the **pelagic food web dynamics** through changes in **ecological interactions**
- A **major change** over the **late 1980s** was revealed in the long term changes of zooplankton. Such change **integrates exceptional events** (burst/drops, phenology) **in zooplankton groups**
- Ecological **warning indicators** of substantial changes in the pelagic ecosystem of the western Europe **related to modifications in the NH climate system**

Thank you