

Workshop 1: Zooplankton and climate: response modes and linkages among regions, regimes and trophic levels

Zooplankton variability in the Balearic Sea and its relation to North Atlantic climate : A boundary area in the Western Mediterranean.

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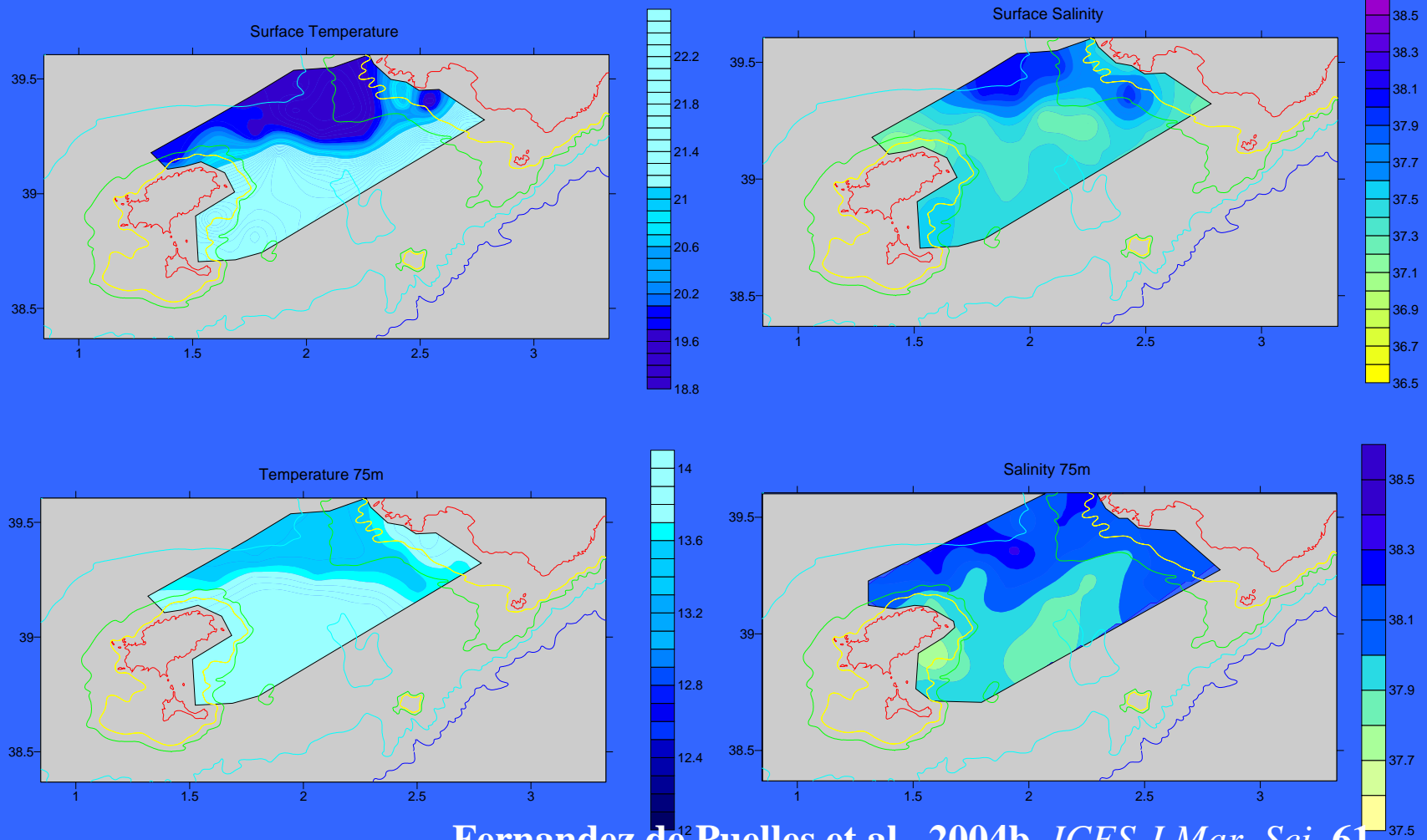
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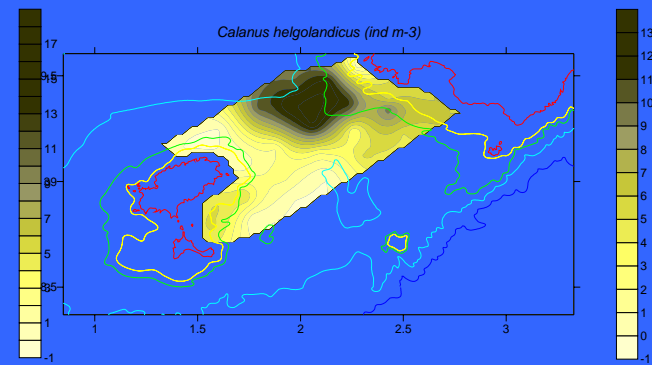
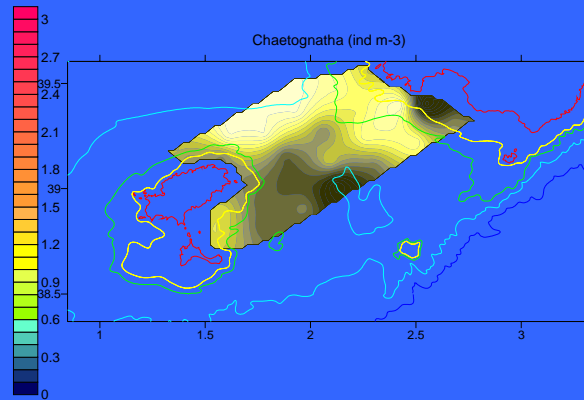
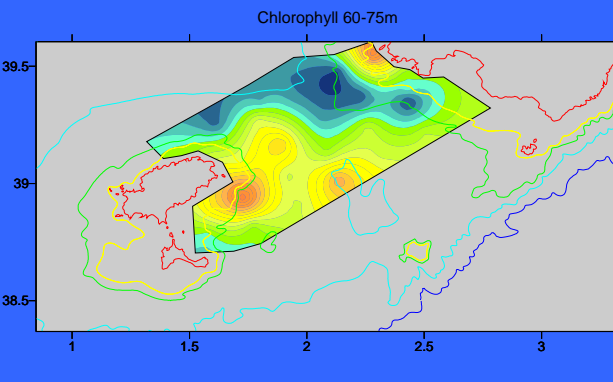
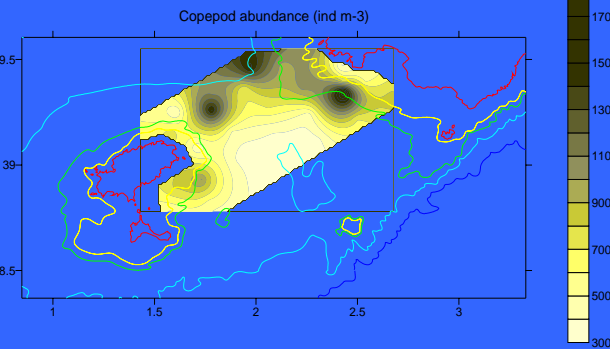
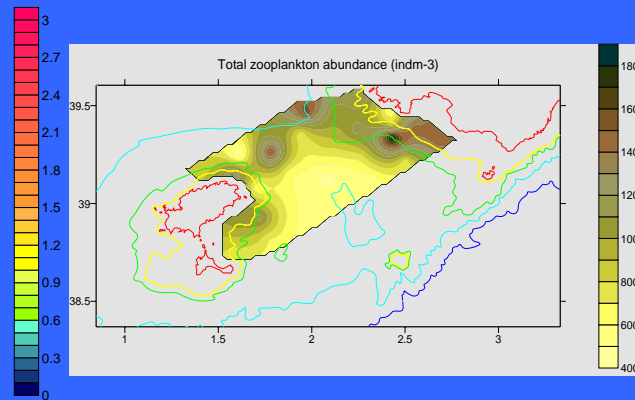
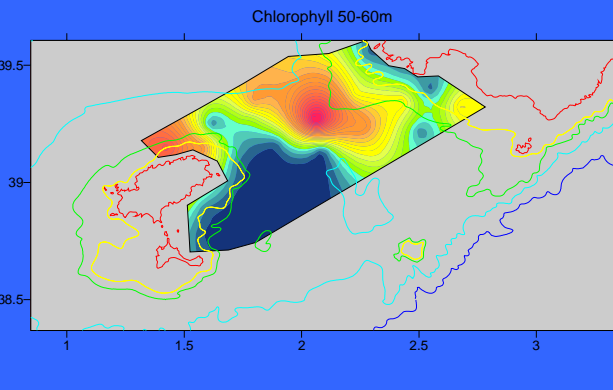
National Project “Oceanographic time-series in the Spanish coast” supported by the I.E.O.

Acknowledgements: The “Arola” crew, B. Amengual, A. Lopez-Urrutia and J. Carranza

Temperature and salinity in the Channel (0-75m): May 2001

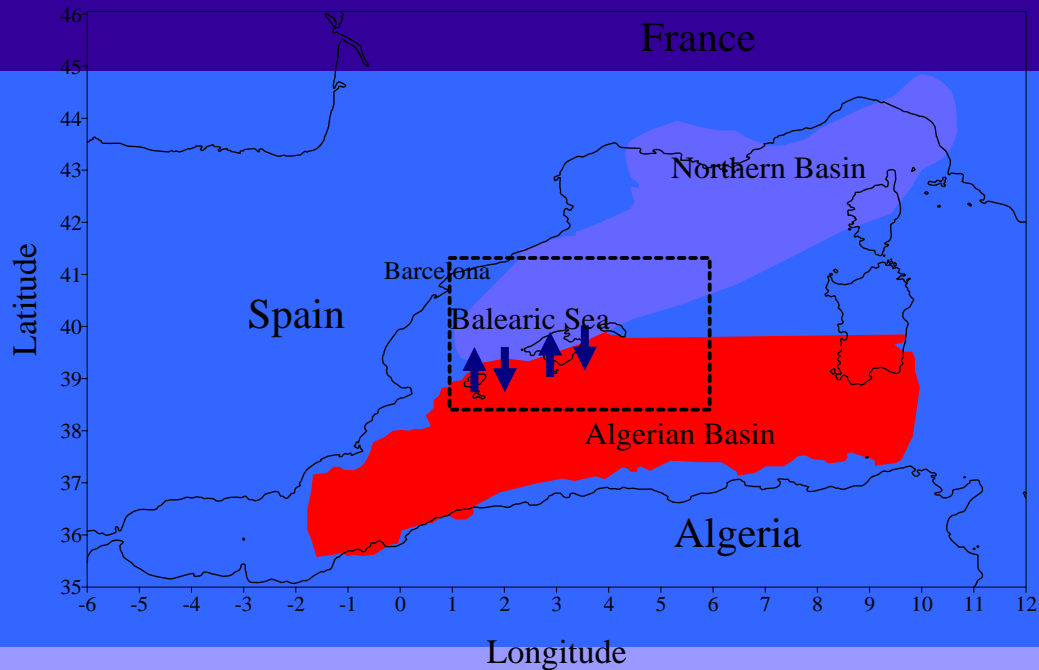


Chlorophyll a and main zooplankton groups: May 2001



Motivation

The Balearic channels are an important passage for the meridional exchanges



* The cooler, more saline water of the Northern basin

* The warmer, fresh waters of the Algerian basin of the WM

- Hence, the BS appears as an ideal site to investigate the dynamics of the surface water masses characterizing the WM basin and therefore to track their effects on
- the functioning of the pelagic ecosystem.

Mallorca channel: St. 1 (75 m) 5 nm from the coast

Sampling station: (39°28'10N; 2°25'E)



Sampling period

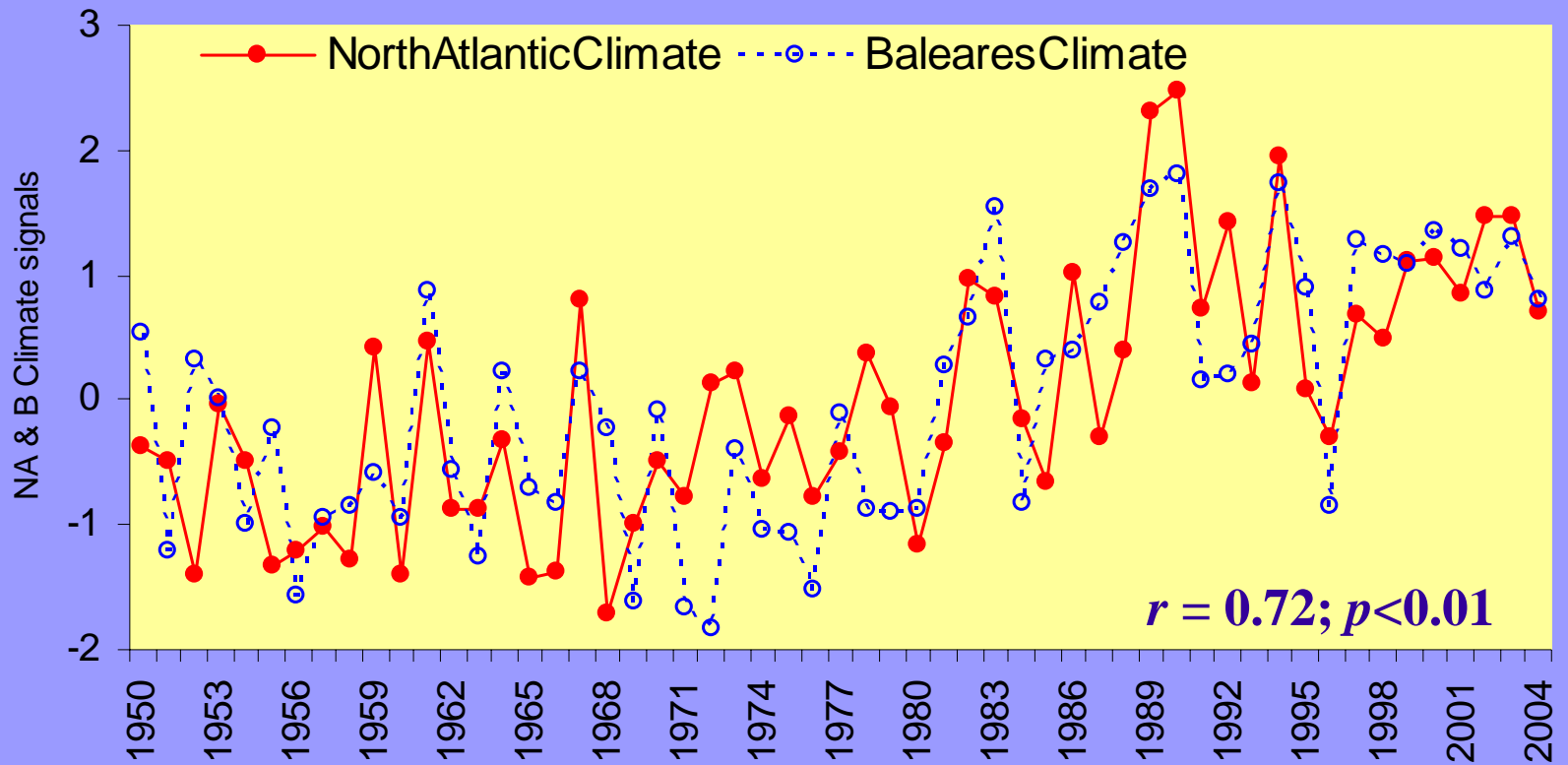
1994 –2004

Every 10 days

Pictures taken from Fernandez de Puelles

Approach :

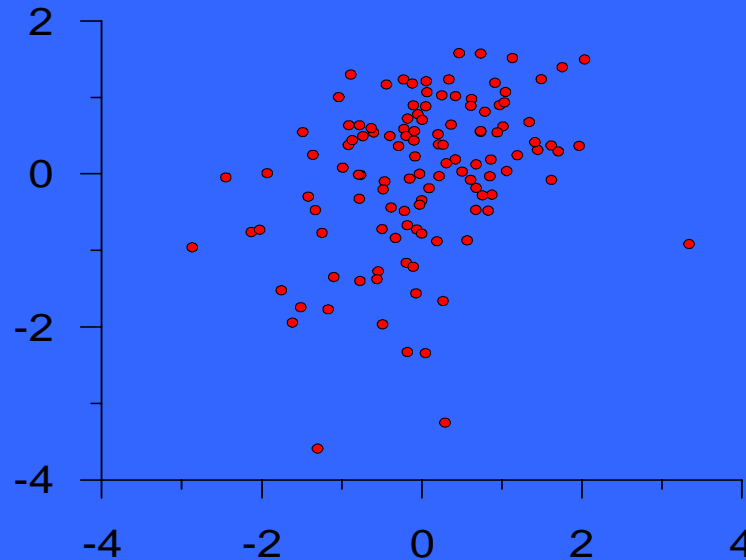
Empirical downscaling to identify links from large to local regional climate and local environmental conditions



Fernandez de Puellas and Molinero, *Geoph. Res. Letter.* 2007

Climate and hydrological variability

We tested the potential link between climate and hydrology in the Balearic Sea



Canonical correlation

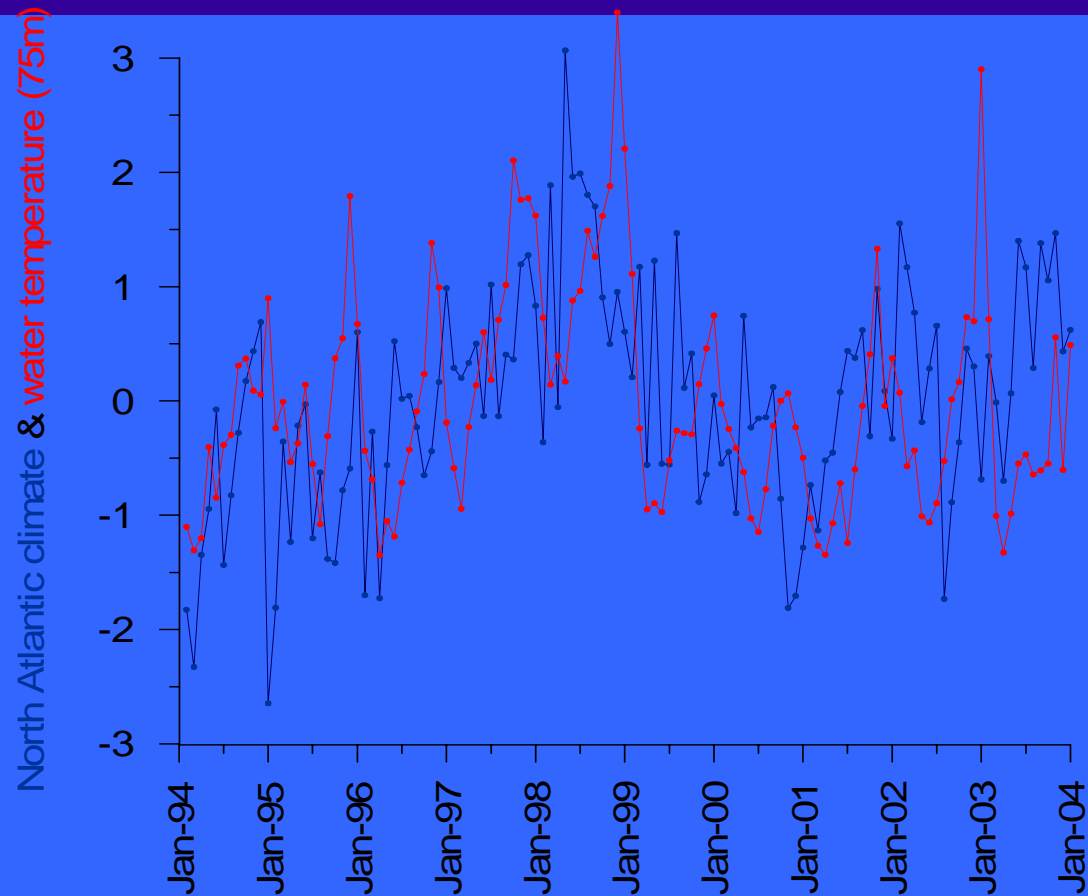
$r = 0.34$; $p < 0.001$

Over the monthly scale

Canonical correlation showed a significant relationship between climate and hydrological properties (temperature and salinity 75 m)

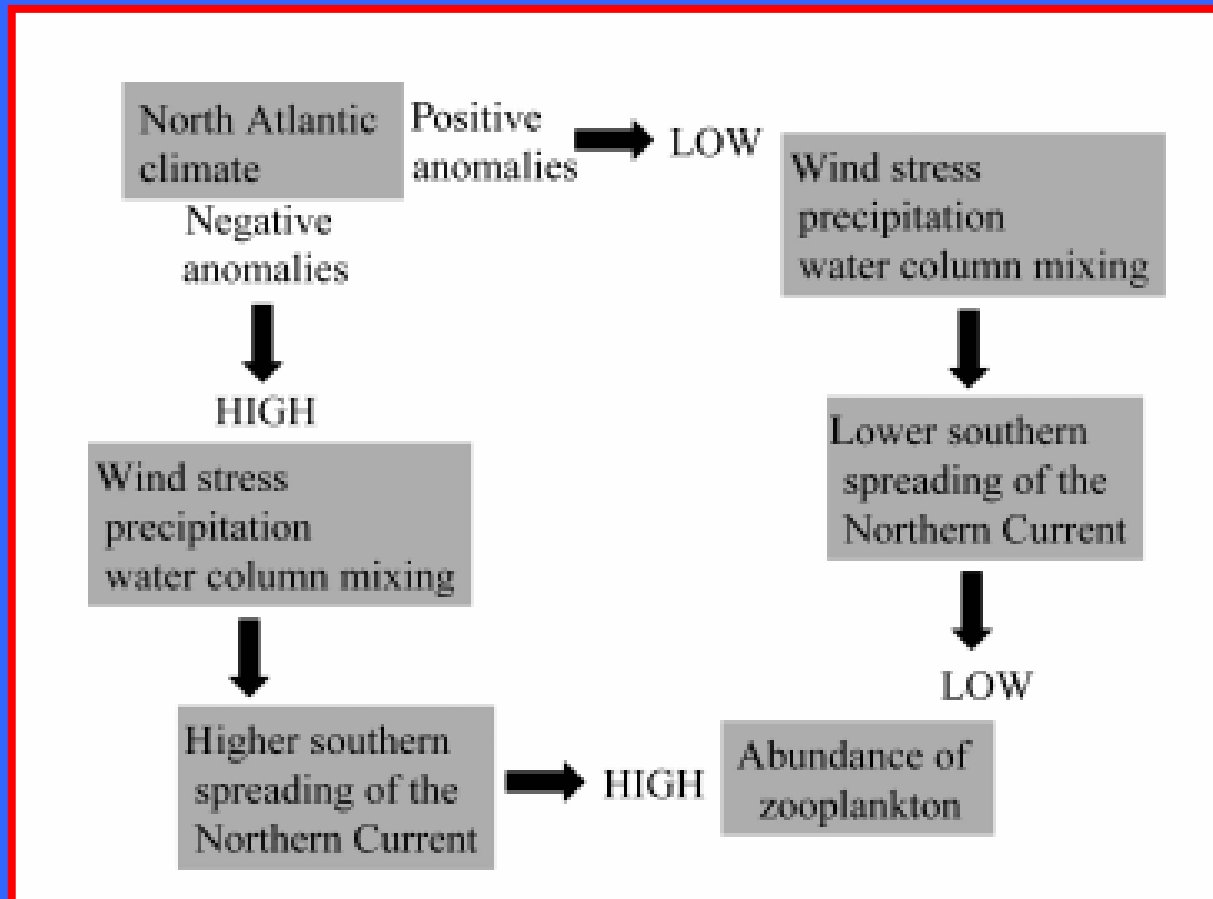
From large to local environmental conditions

North Atlantic Climate and hydrological variability



Fernandez de Puellas and Molinero, *Geoph. Res. Letter.* 2007

From large to local environmental conditions



Canonical Correlations

NA Climate-Balearic Sea $r = 0.63$; $p < 0.001$

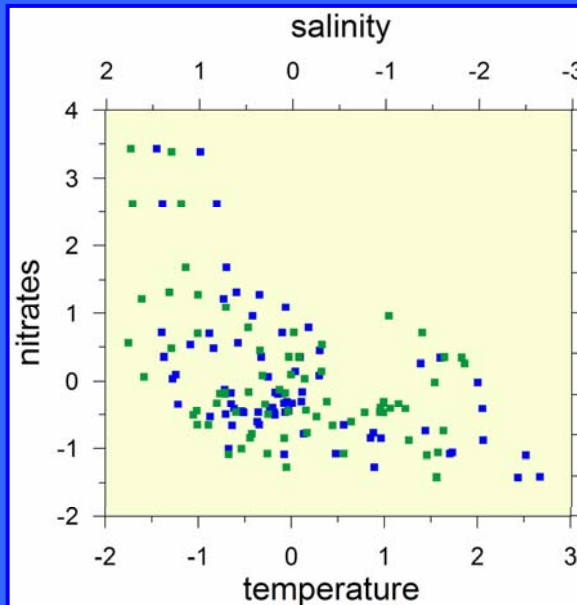
NA Climate-Temperature $r = 0.59$; $p < 0.001$

NA Climate-Salinity $r = 0.27$ ns

NA Climate-Nitrates $r = -0.41$; $p < 0.01$

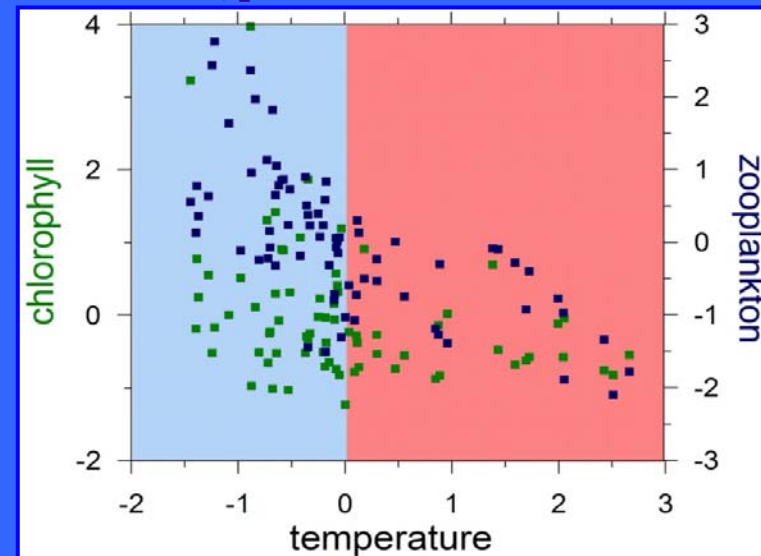
**From large to local
environmental conditions**

Through hydrological variations, climate affects plankton



Salinity-Nitrates $r = 0.48$; $p < 0.001$

Temperature - Nitrates $r = -0.51$; $p < 0.001$

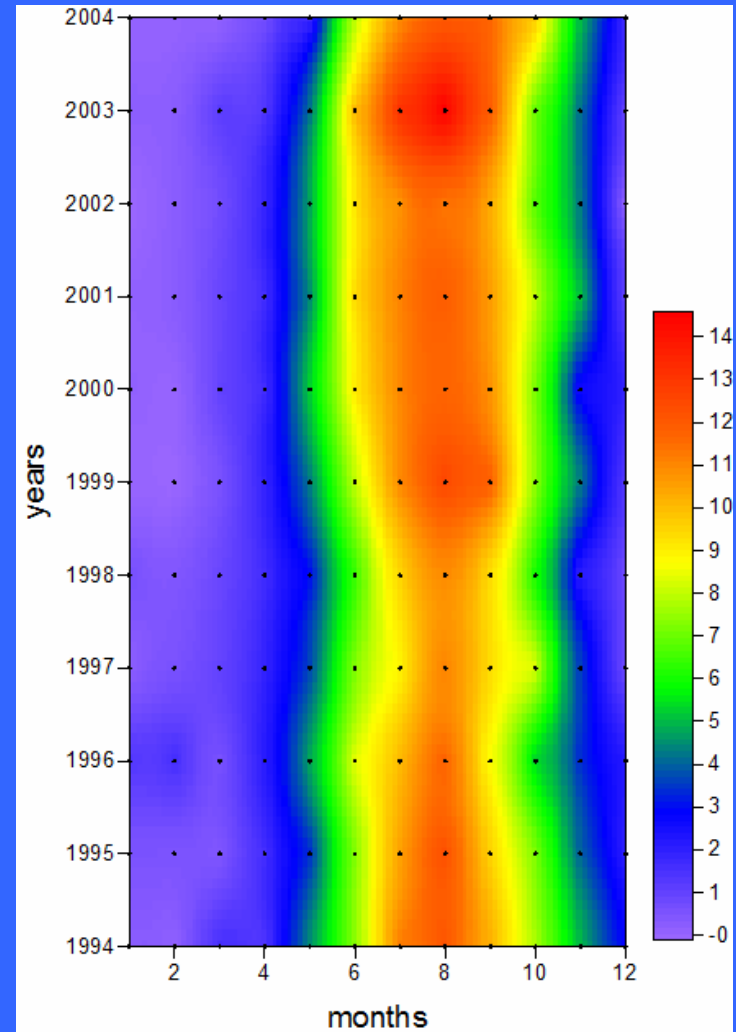
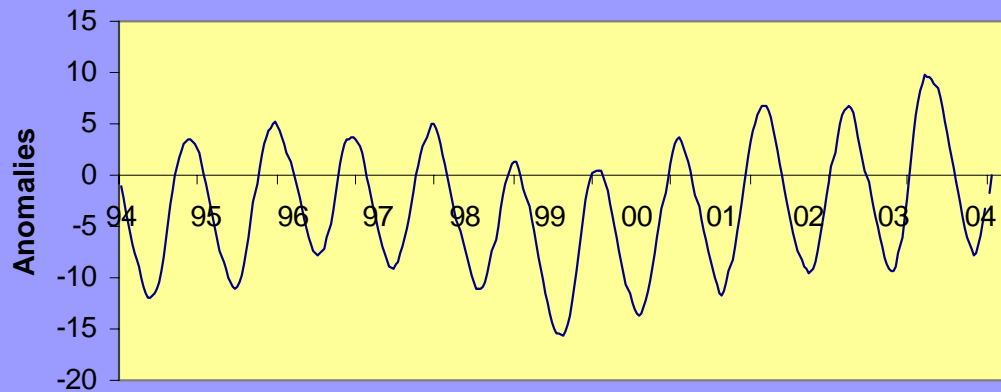


Temp - Chlorophyll a $r = -0.5$; $p < 0.01$
Temp - Zooplankton $r = -0.68$; $p < 0.001$

Chla - Zoo : $r = 0.30$; $p < 0.01$

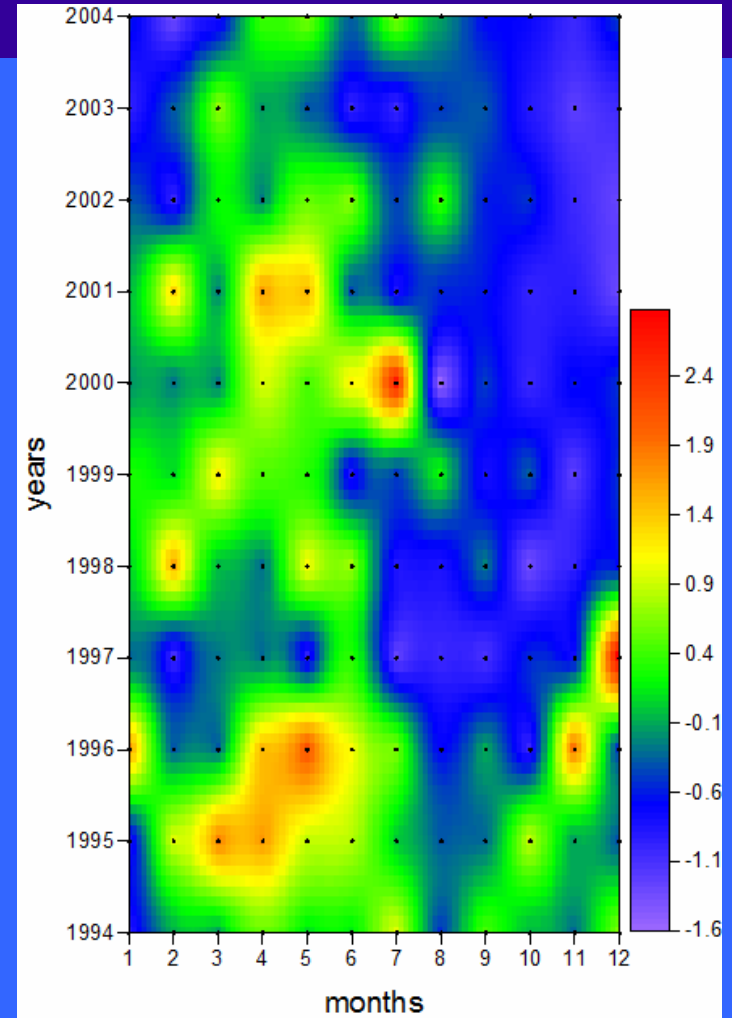
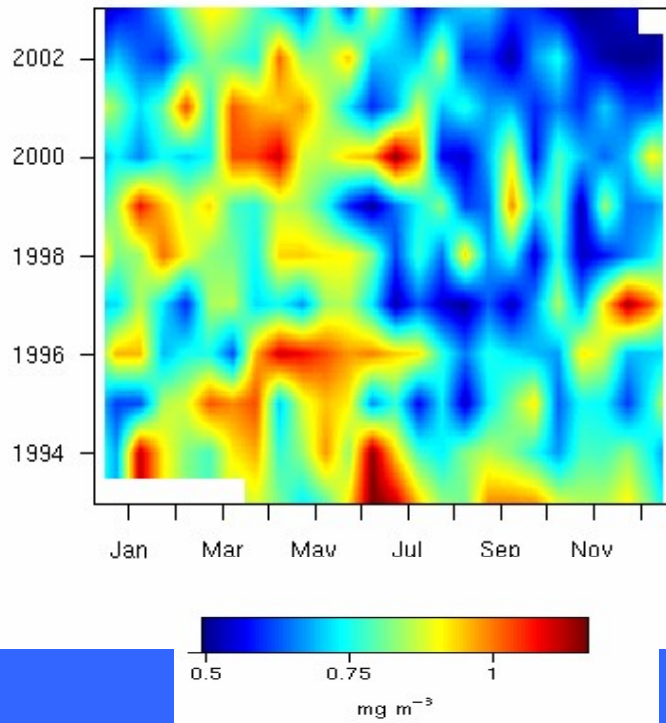
Stratification index

Stratification index

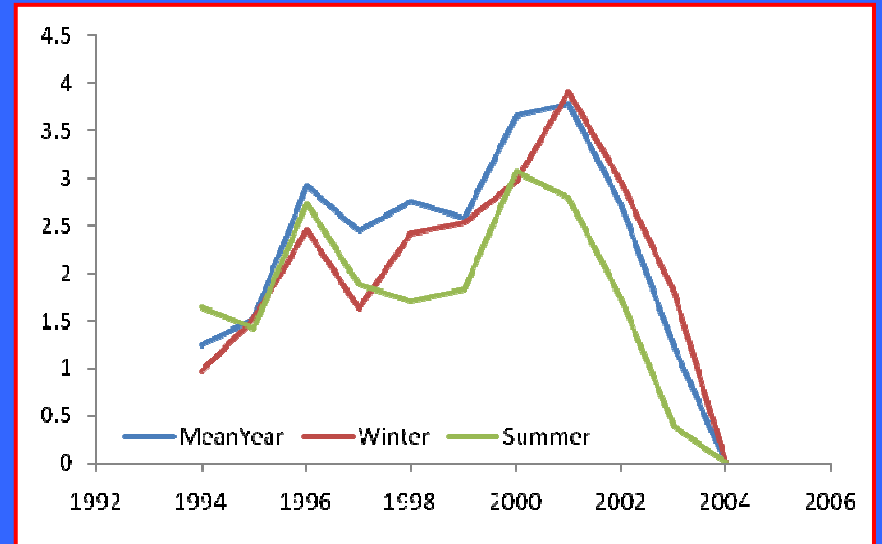
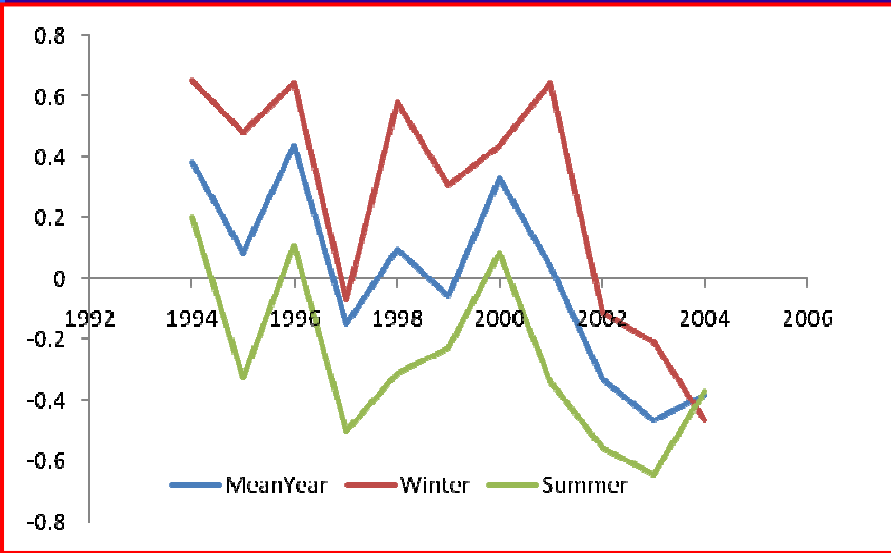


Zooplankton biomass variability

zooplankton biomass



Zooplankton abundance variability



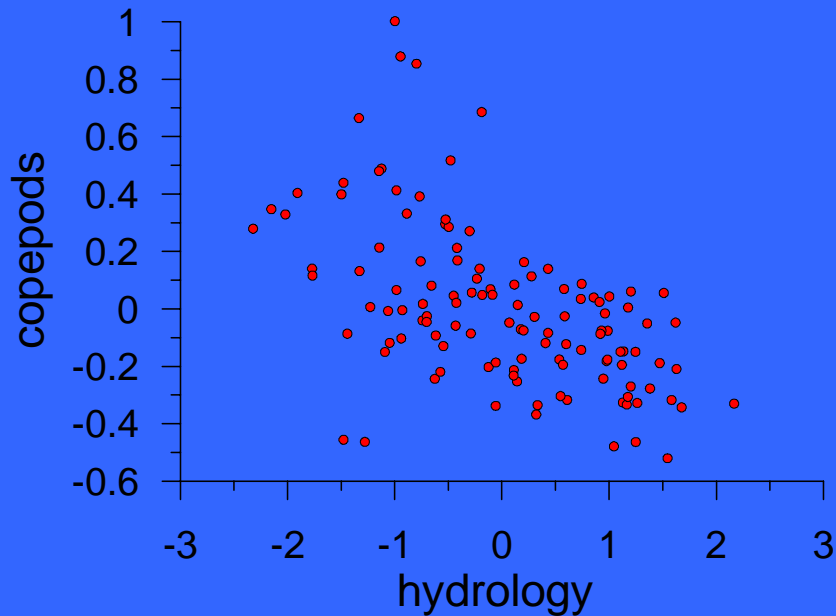
Hydrology and zooplankton variability

Canonical correlations between hydrological variability and zooplankton abundance

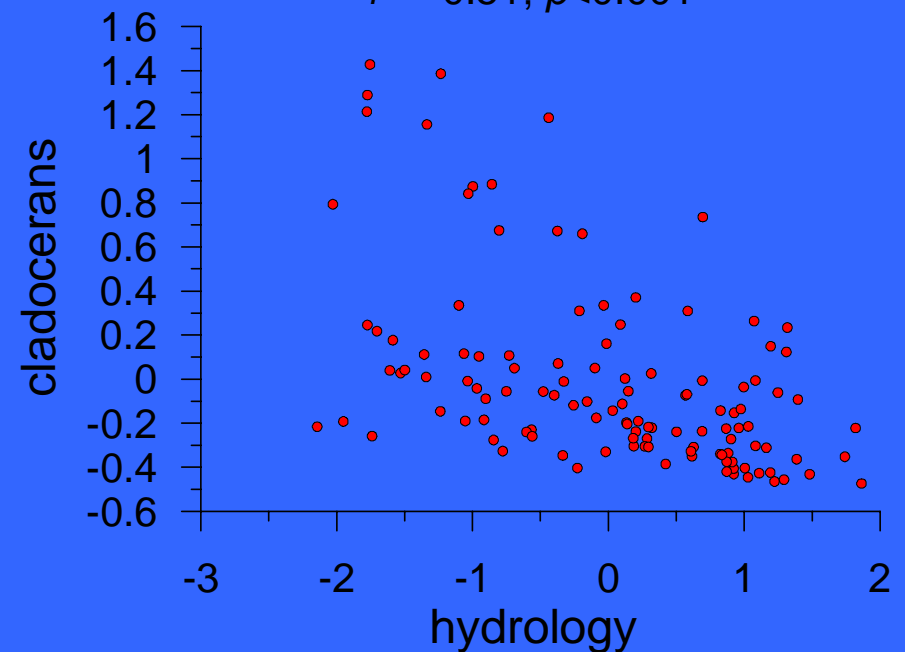
	r	p
CCA1 Copepods	0.64	0.0001
CCA1 Appendicularians	0.52	0.0001
CCA1 Chaetognaths	0.48	0.0001
CCA1 crustacean larvae	0.51	0.0001
CCA1 salps	0.36	0.0001
CCA1 ostracods	0.58	0.0001
CCA1 pteropods	0.59	0.0001
CCA1 meroplankton larvae	0.60	0.0001
CCA1 medusa	0.45	0.0001
CCA1 siphonophores	0.59	0.0001
CCA1 doliolides	0.43	0.0001
CCA1 cladoceres	0.64	0.0001

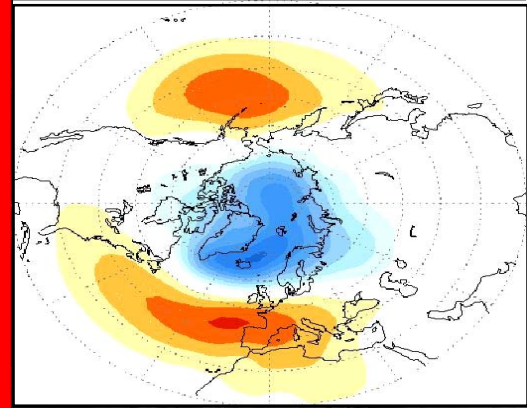
Sensitivity of zooplankton groups (monthly scale)

$r = -0.55; p < 0.001$



$r = -0.51; p < 0.001$





**North Atlantic
atmospheric circulation**

Regional atmospheric circulation

**Water mass transport & meridional
in the Mallorca Channel**

Mixing water and stratified period

Chlorophyll

Zooplankton



Main remarks

- A **close connection** emerges between **large and regional climate** in the central WM. Such link chiefly affects regional hydrographic features whose long-term variability may be considered as NA climate **fingerprints** in the Balearic Sea
 - Water **temperature** emerged as a potential mediator factor linking climate and zooplankton changes, although **salinity** conditions related to nitrates and chlorophyll were also **tightly connected to climate**
- **Zooplankton** groups were significant related to **hydrographic variability**, however the responses varied according to different life-histories of zooplankton groups. So that, they can be used as a **valuable indicator of basin scale environmental variability and climatic change**
- During the 11 year study, **more saline and cooler waters** were observed in the BS in relation to zooplankton structure, and also a more **intense stratification** period seems to highly affect the total **zooplankton biomass and abundance**
- Our results may have important implications for the **assessment or spawning areas of pelagic fish** which indirectly are affected by the climatic-related fluctuations of zooplankton abundance