Climate and gelatinous carnivores in semi-closed, small-oceans: the NW Mediterranean case study

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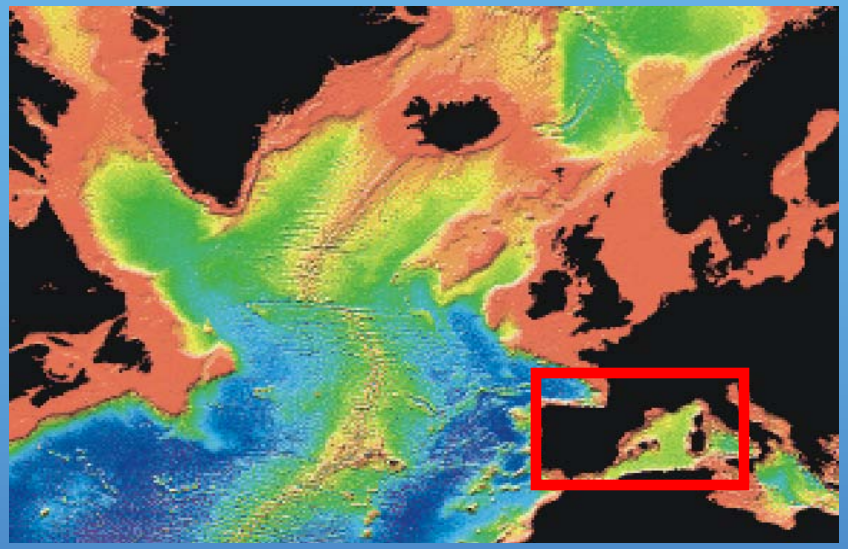
Compared to geographical sites of previous regional climate-plankton investigations



NW Mediterranean

* Southern latitudinal position and warmer prevailing weather conditions

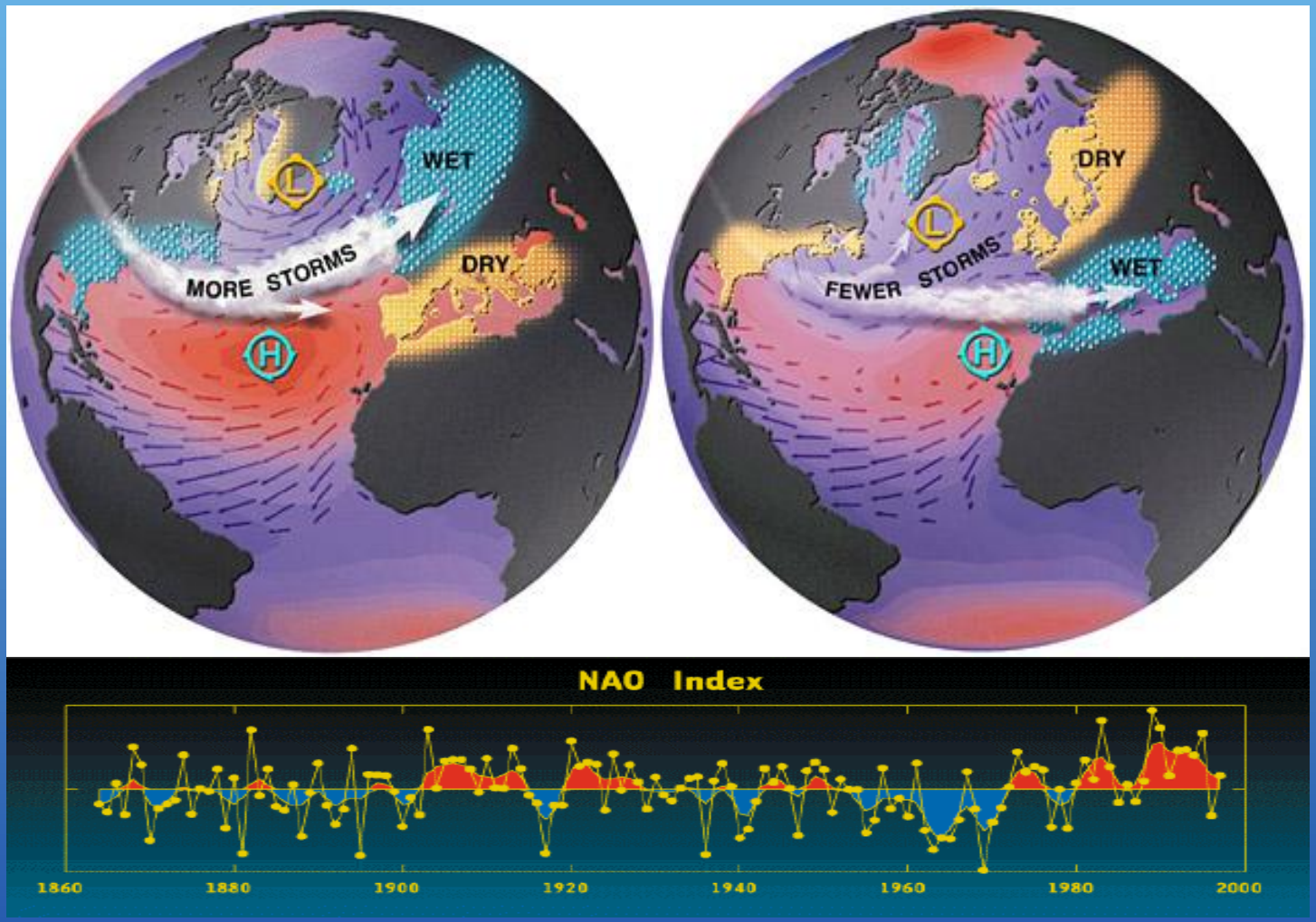
* climatic, socio-economic and ecological interest

* influenced by some of the most dominant mechanisms driving the global climate system (i.e. NAO)

NAO effects on surronding continents

Positive phase

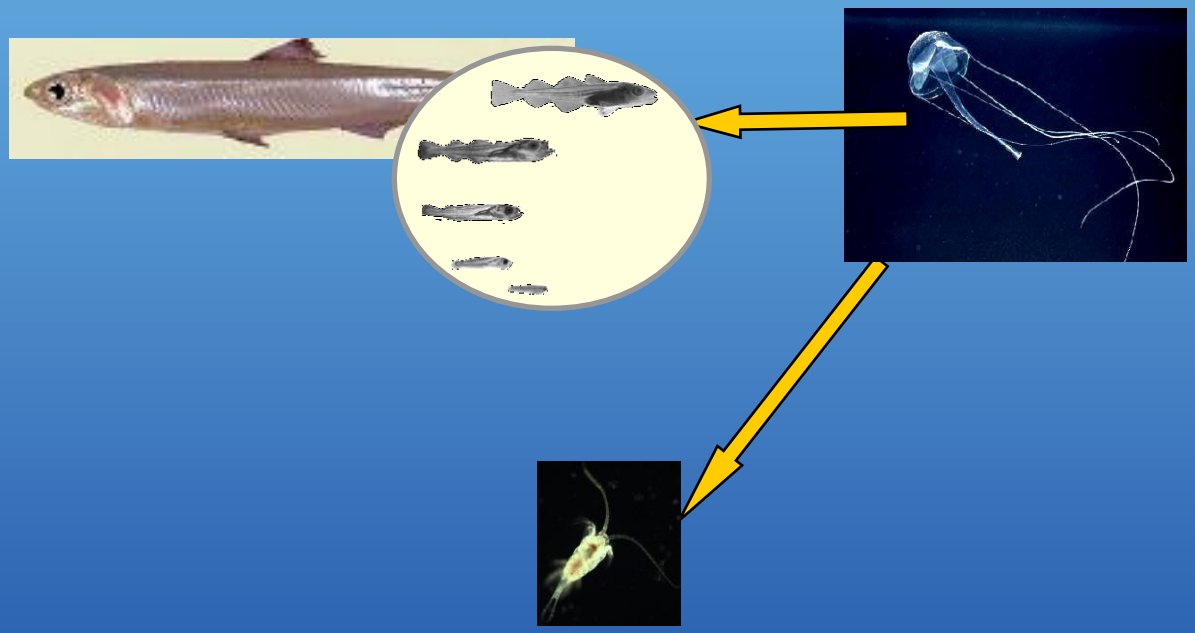
Negative phase



The link with gelatinous zooplankton in the Northwestern Mediterranean has been few explored…

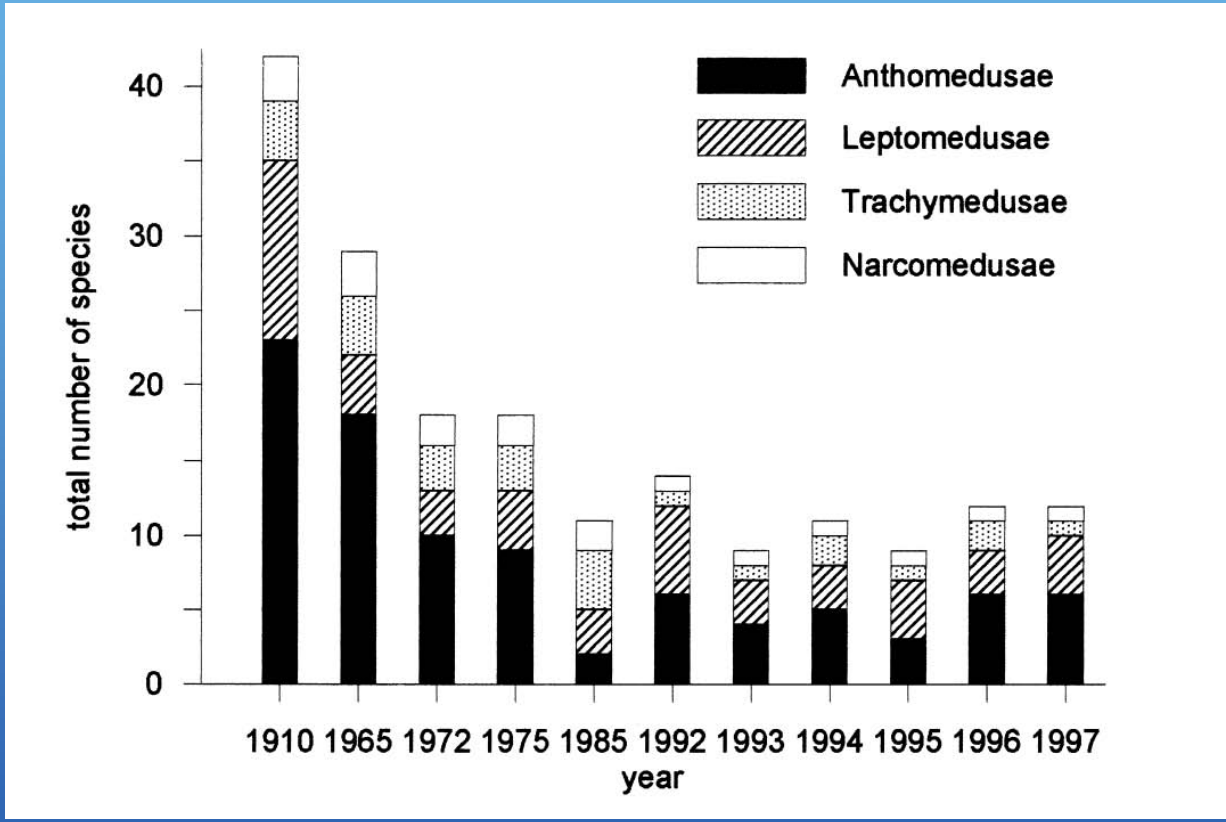
Gelatinous carnivores: the ecological importance

High abundances may channel the energy flow away from fish and then affect drastically the ratio fish:primary production



Particular ecological importance because of their potential effect on the population size of mesozooplankton and fish recruitment

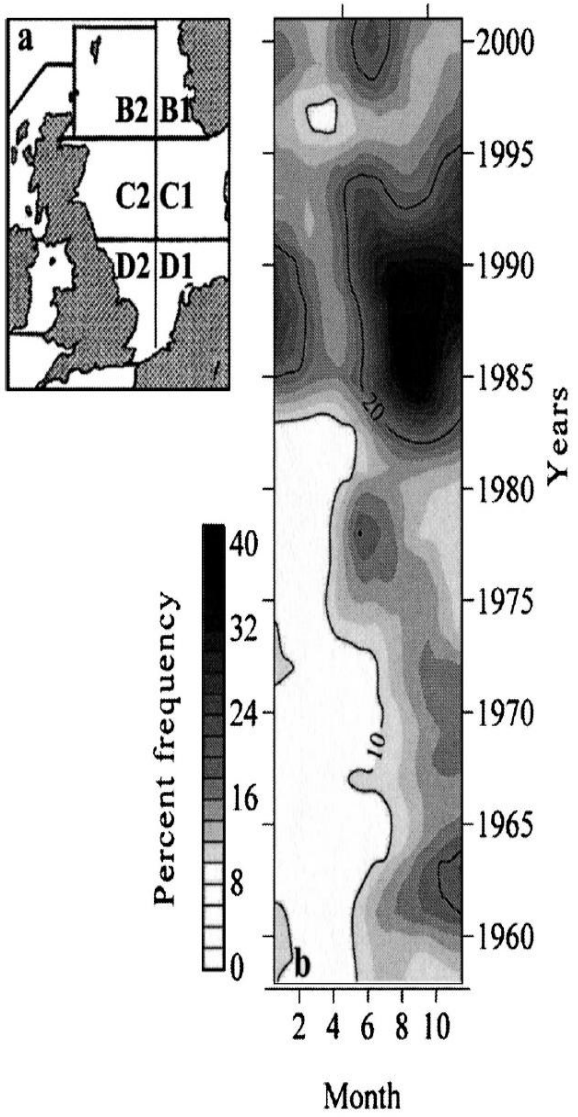
gelatinous carnivores are now recognized as critical indicators and drivers of ecosystem change



After Benovic et al. 1987

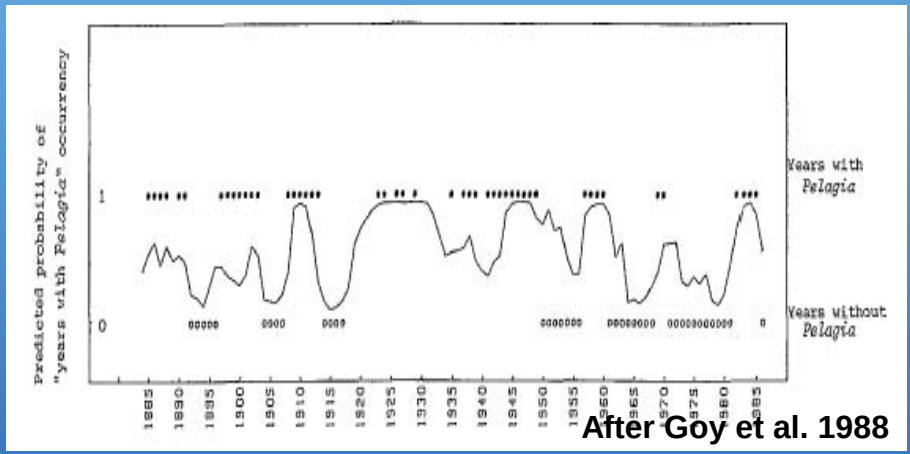
i.e. Diversity changes in medusae in the Adriatic Sea associated to anoxia events

Increasing outbreaks have been associated to regime shifts in marine ecosystems

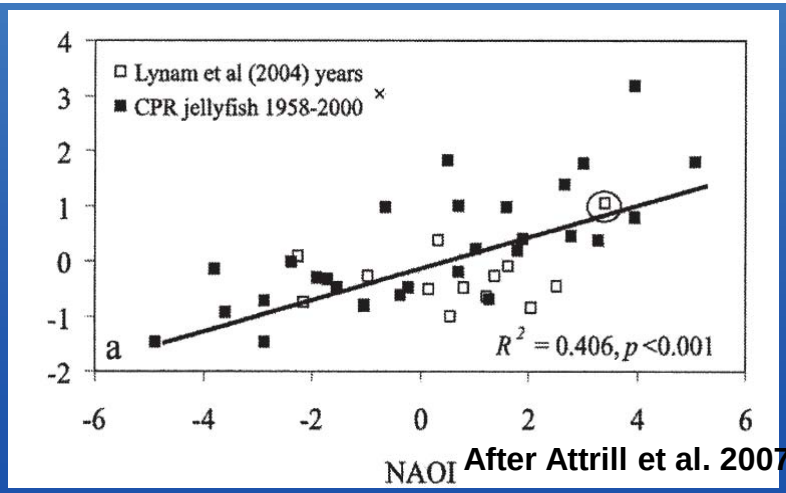


After Attrill et al. 2007

and they appear driven by climate variations

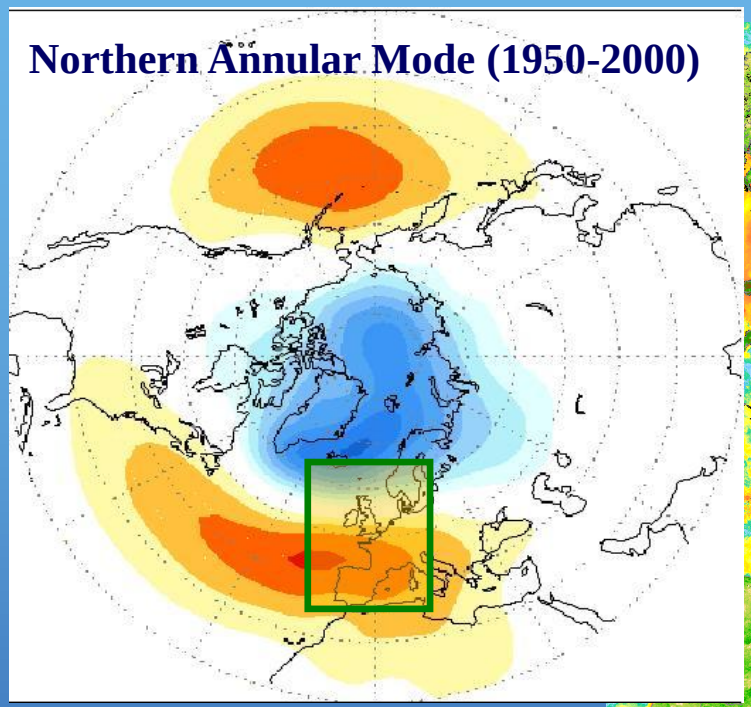


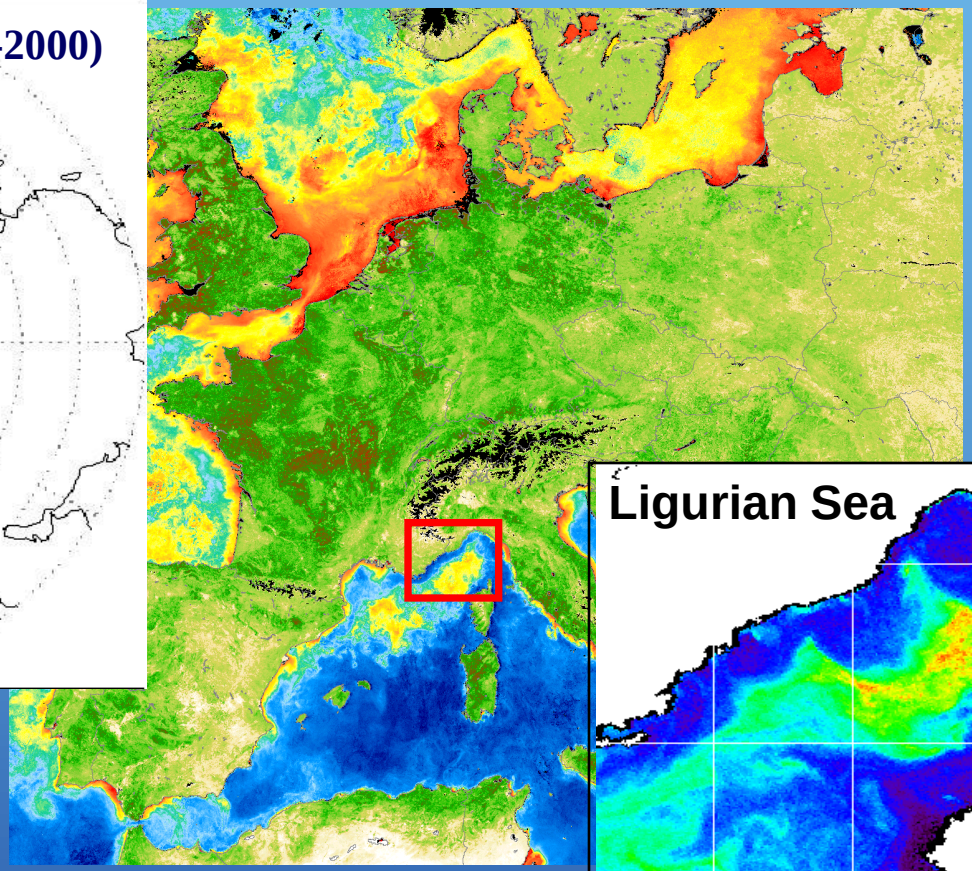
After Goy et al. 1988



After Attrill et al. 2007

Study site

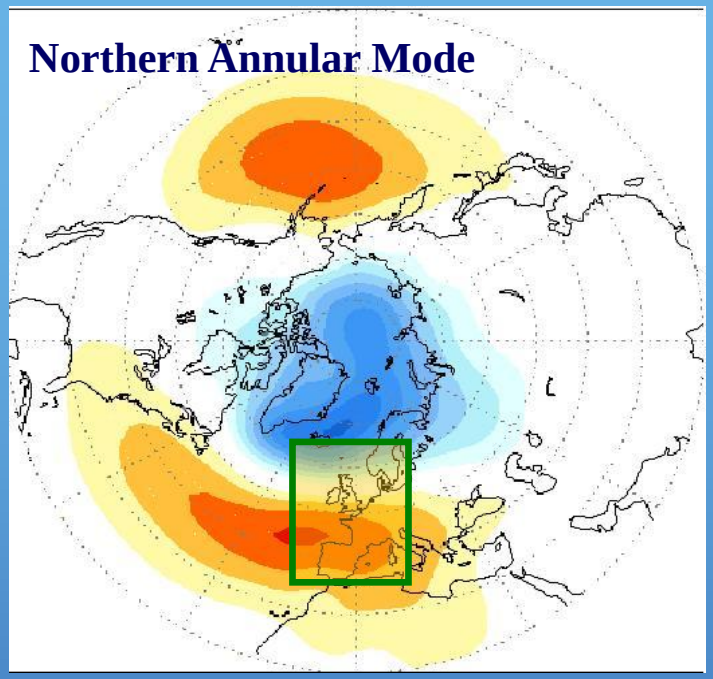


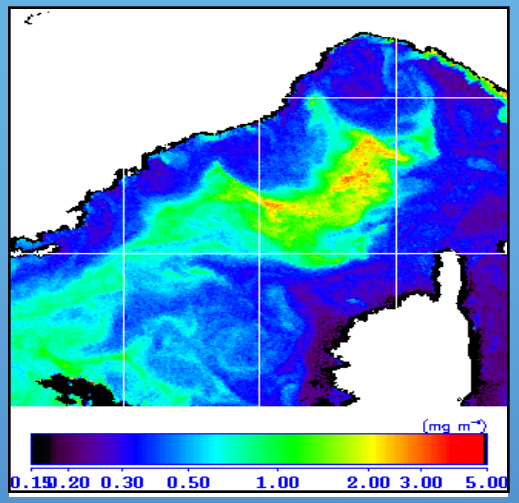


➔ zooplankton monitoring since the late 1960s

➔ Highly sensitive to large scale atmospheric forcing

Data & scales





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

NAO/AO
Northern Hemisphere temperature
East Atlantic Pattern

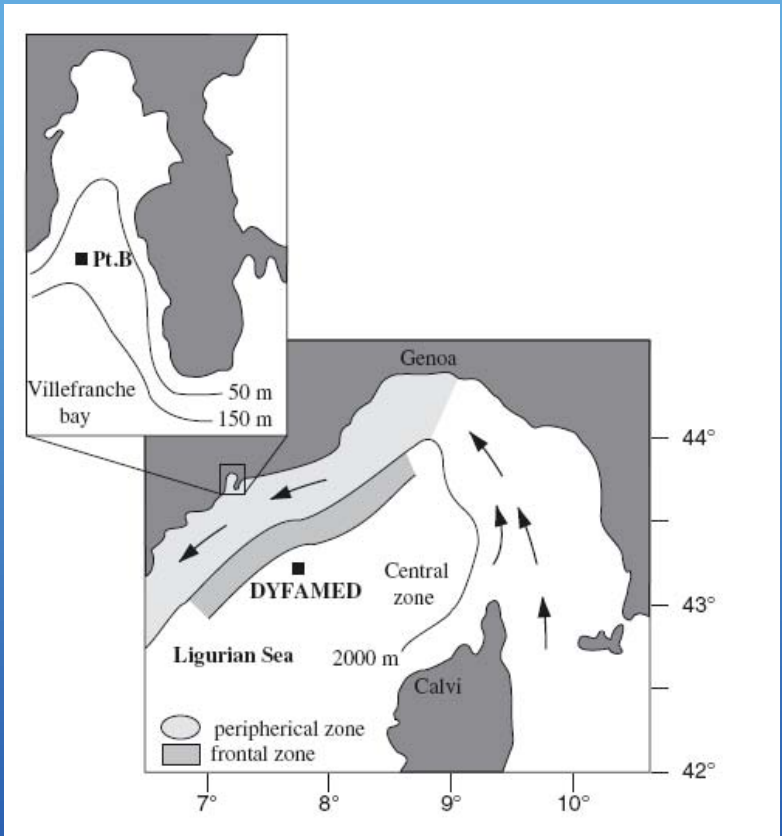
} **Large scale**

atm. pressure, air temperature, irradiance, precipitation, 500 hPa (ICOADS, 1950-2005)

} **Regional Scale (Ligurian basin)**

Data & scales

Villefranche Bay, North of the Ligurian Sea



After Beauvais et al. 2003, MEPS

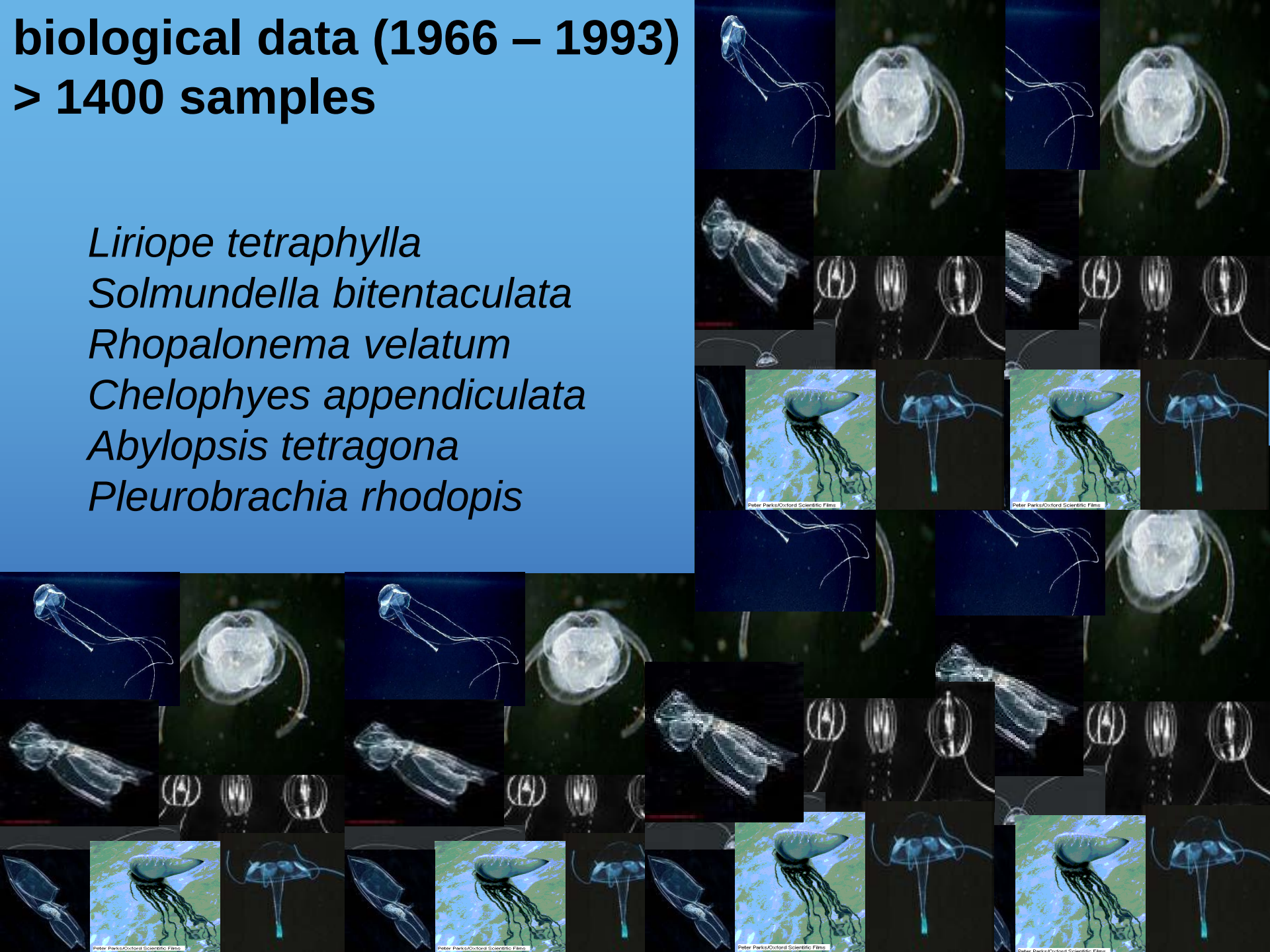
Physical data :
***Local meteorology: atm. pressure, air temperature, irradiance, precipitation, wind speed (daily frequency)**

***Hydrology: temperature (weekly frequency)**

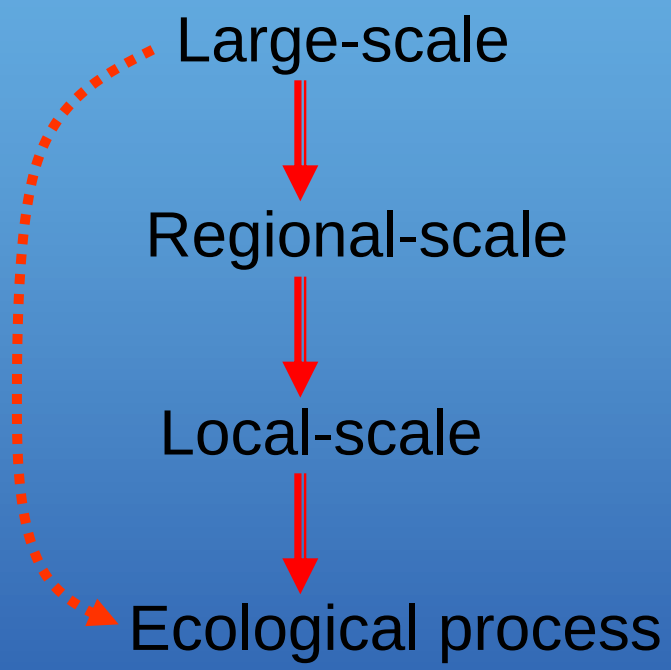
Local scale

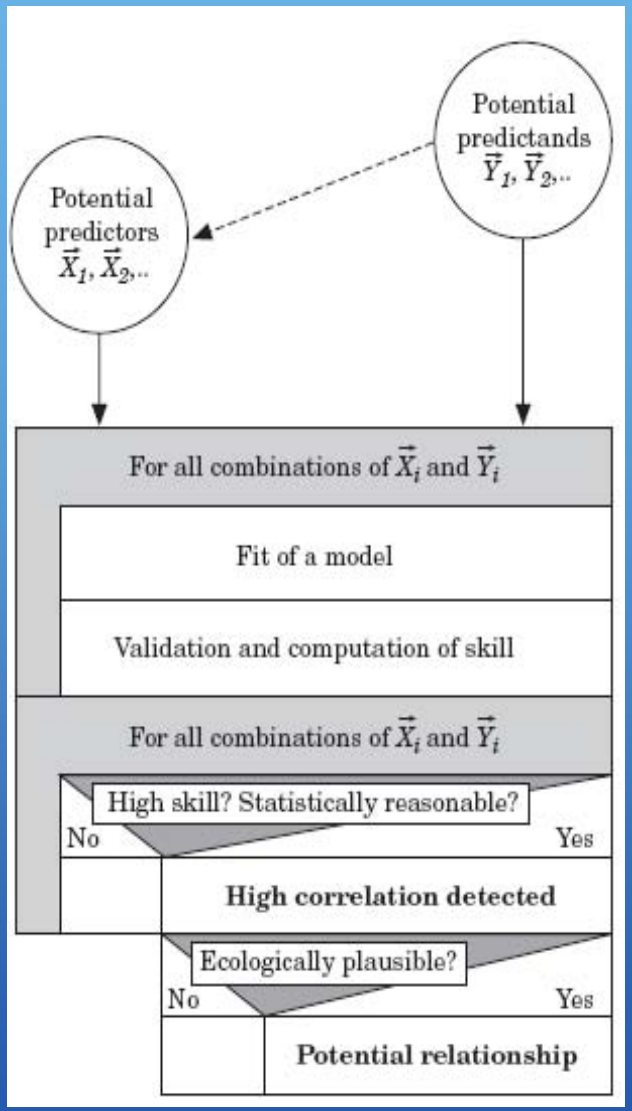
biological data (1966 – 1993)
> 1400 samples

Liriope tetraphylla
Solmundella bitentaculata
Rhopalonema velatum
Chelophyes appendiculata
Abylopsis tetragona
Pleurobrachia rhodopis



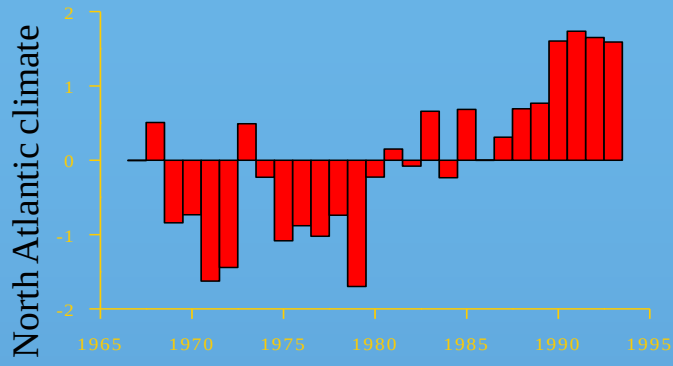
Statistical Downscaling





von Storch et al.1993
Dippner et al. 2001; Molinero et al. 2007

The downscaling link



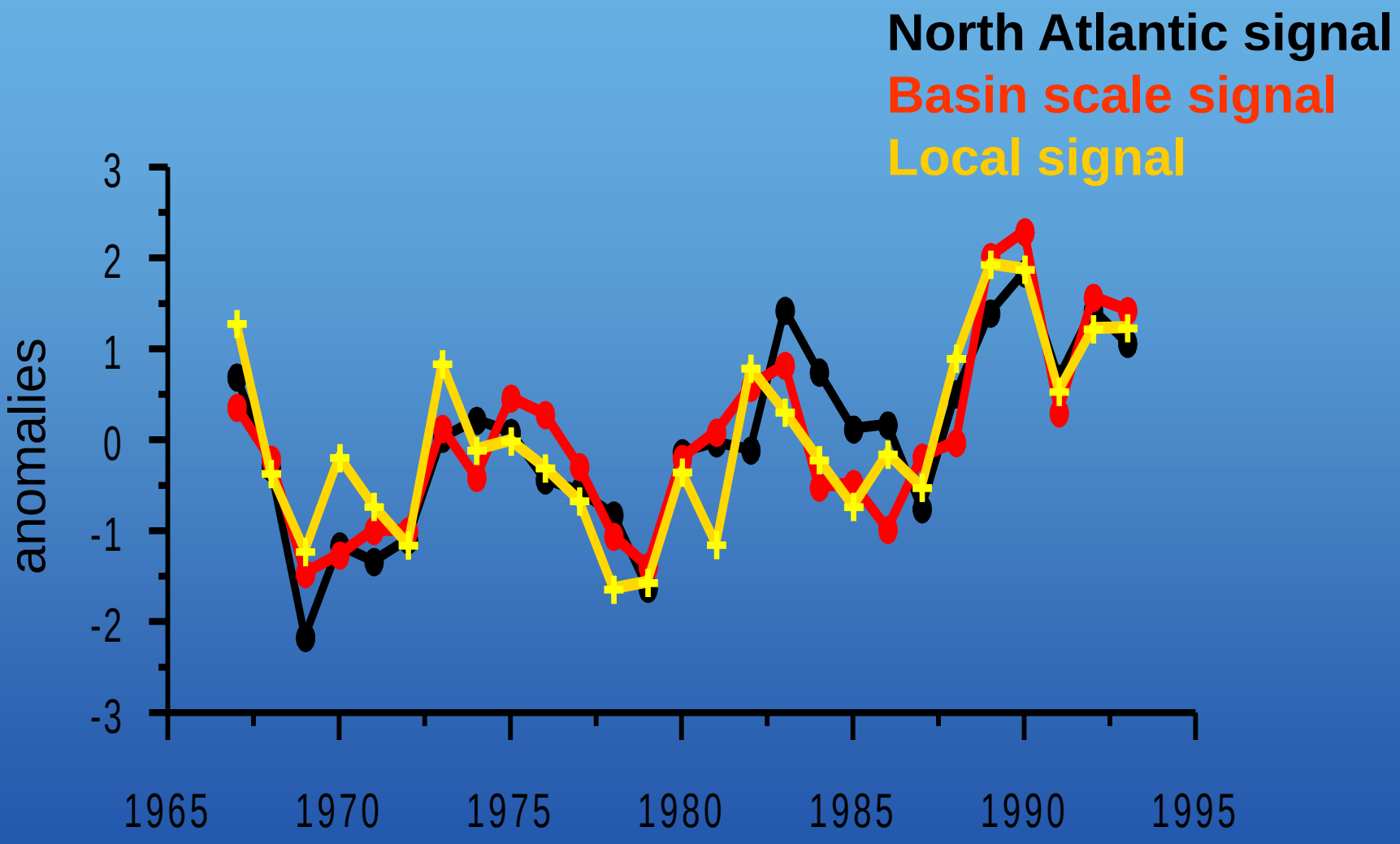
North Atlantic climate

Regional climate (Ligurian Sea)

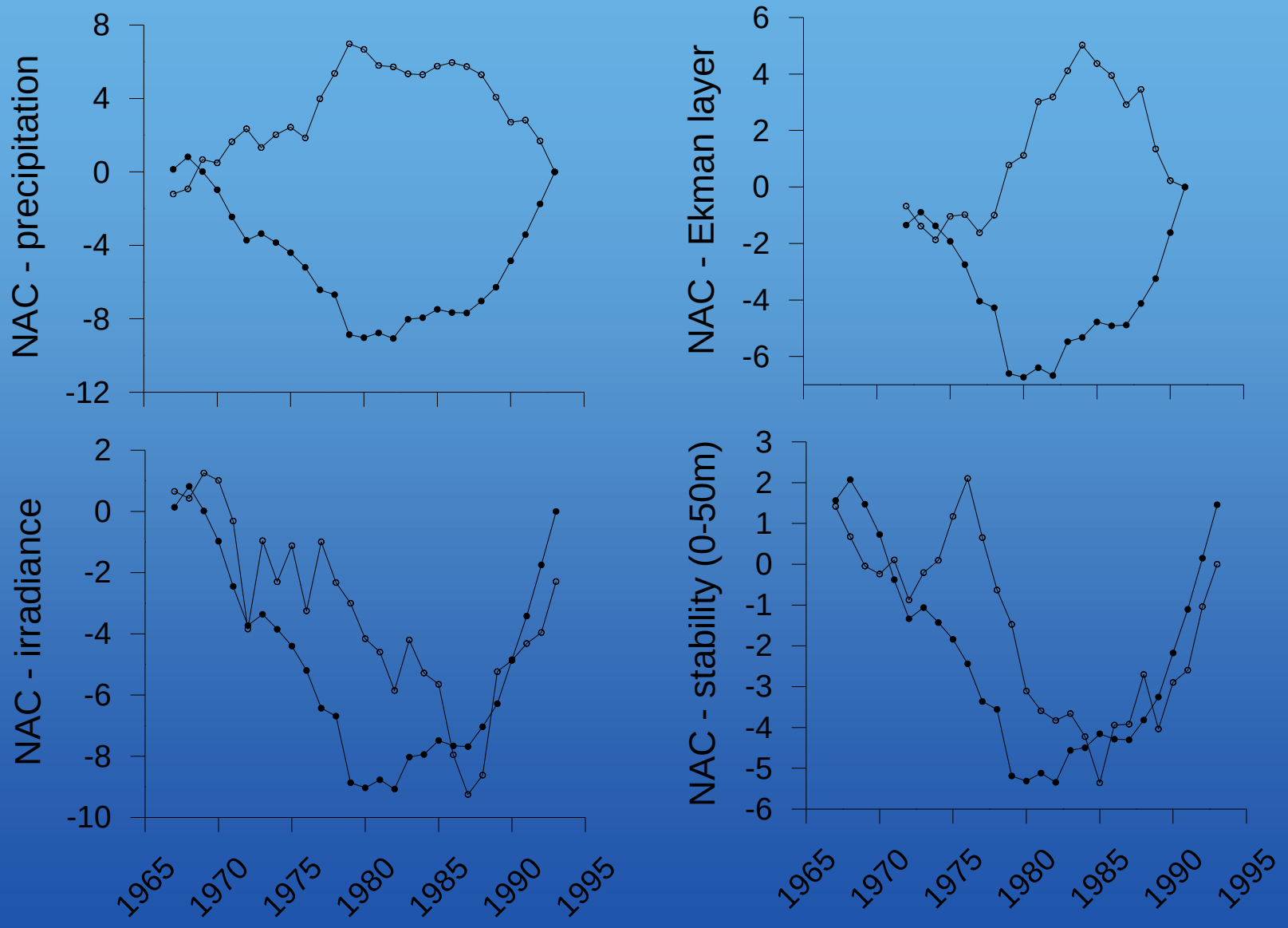
Local climate (Bay of Villefranche)

Water temperature

from the North Atlantic to the Ligurian Sea



North Atlantic climate and local hydro-climate



Large-scale

Regional-scale

Local-scale

Ecological process

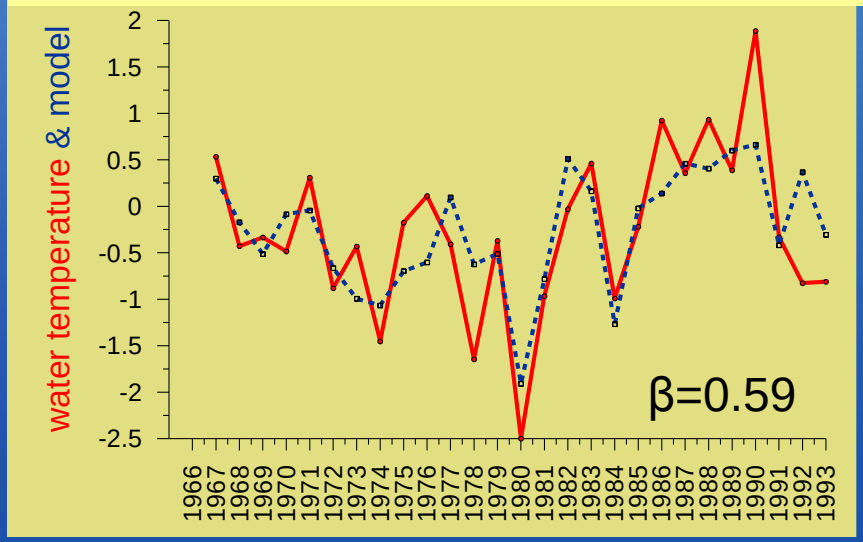
Surface atmospheric pressure

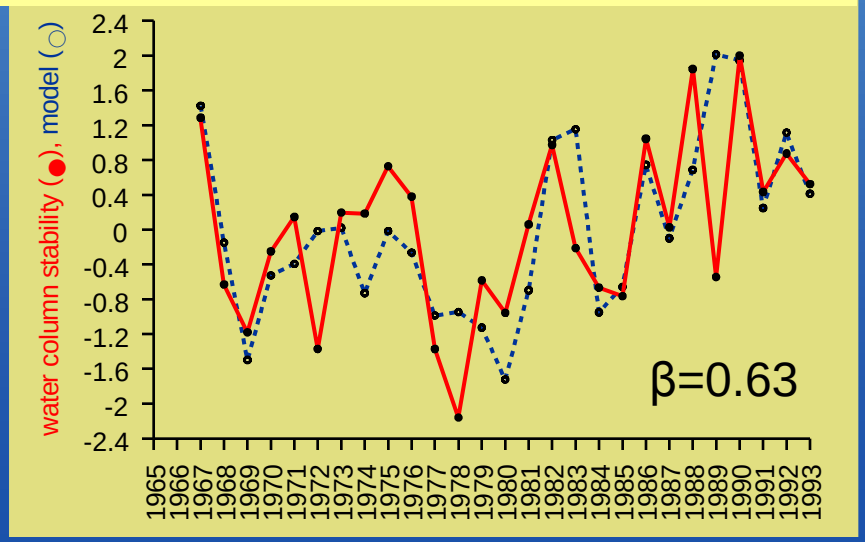
Precipitation

500 hPa

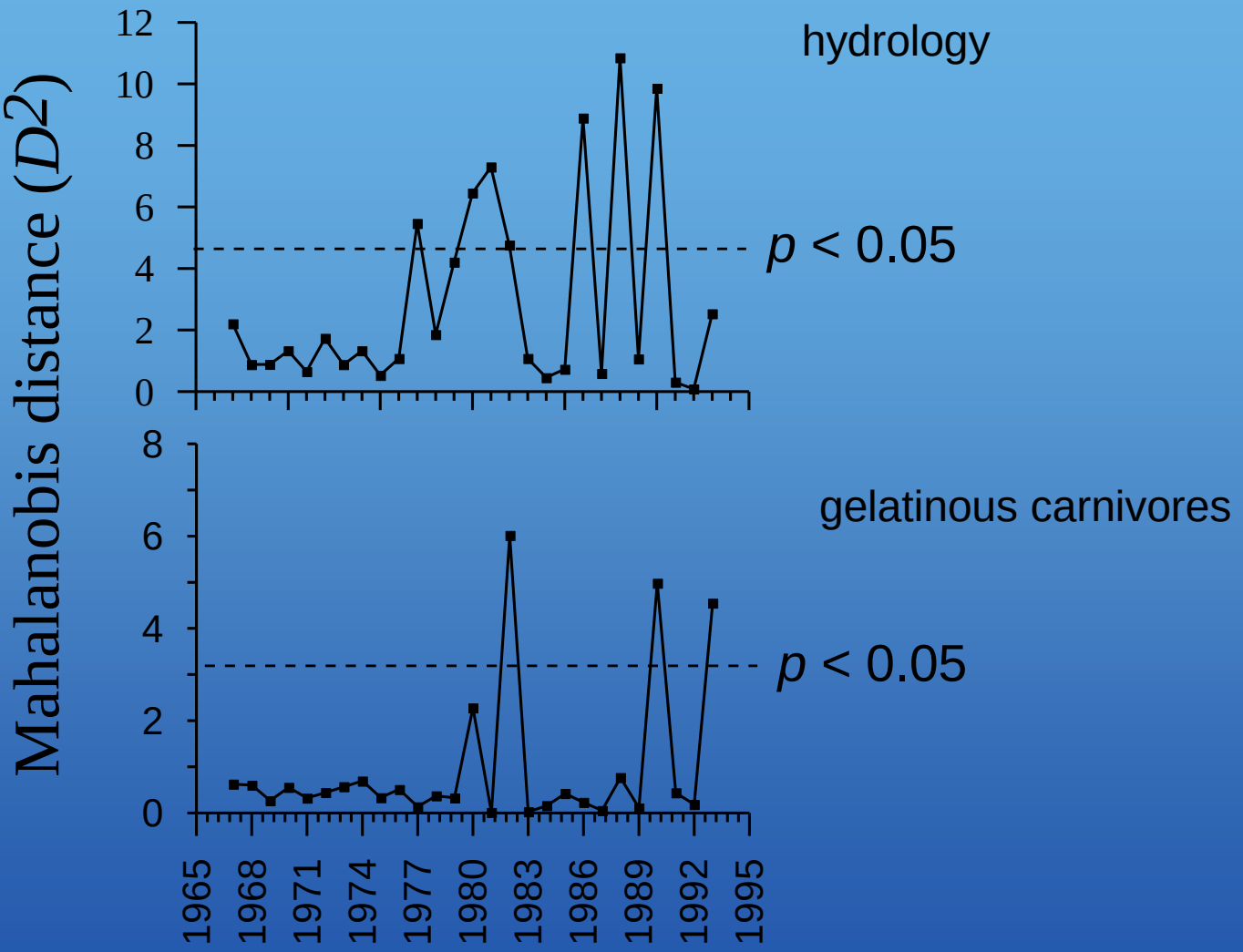
Sea surface temperature

By using the proxies of NA and regional climates to build up the downscaling model it is shown that a substantial amount of variability is associated to meteorological forcing

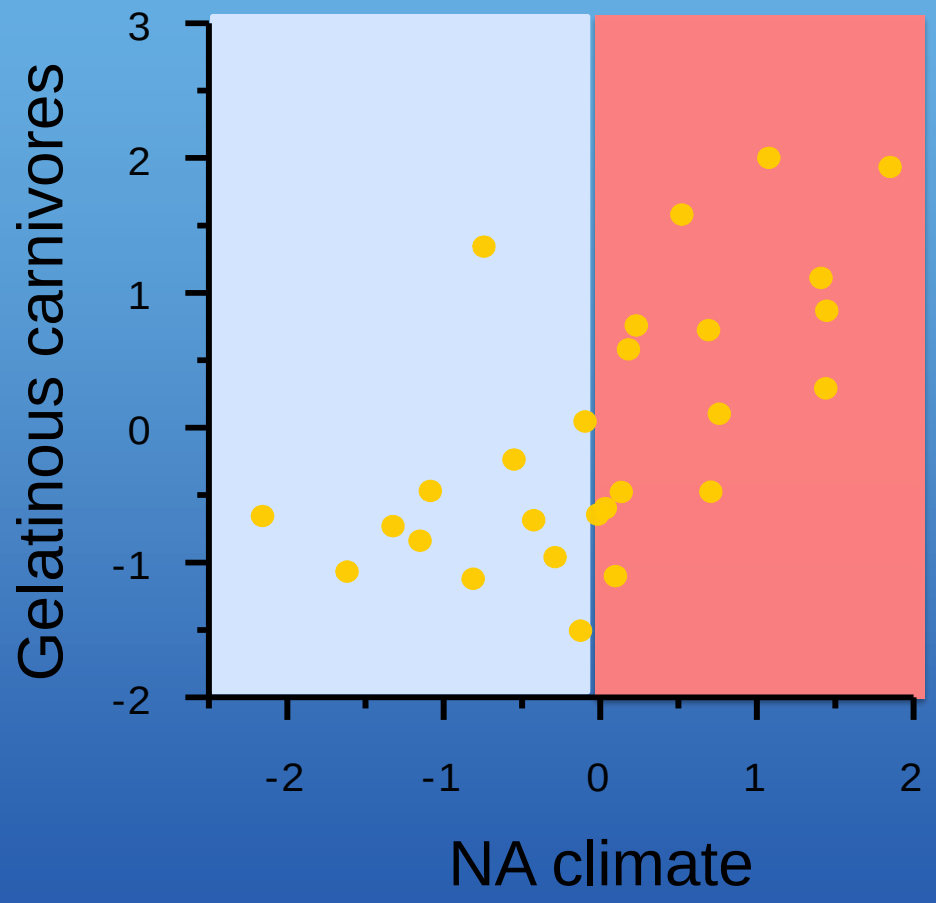




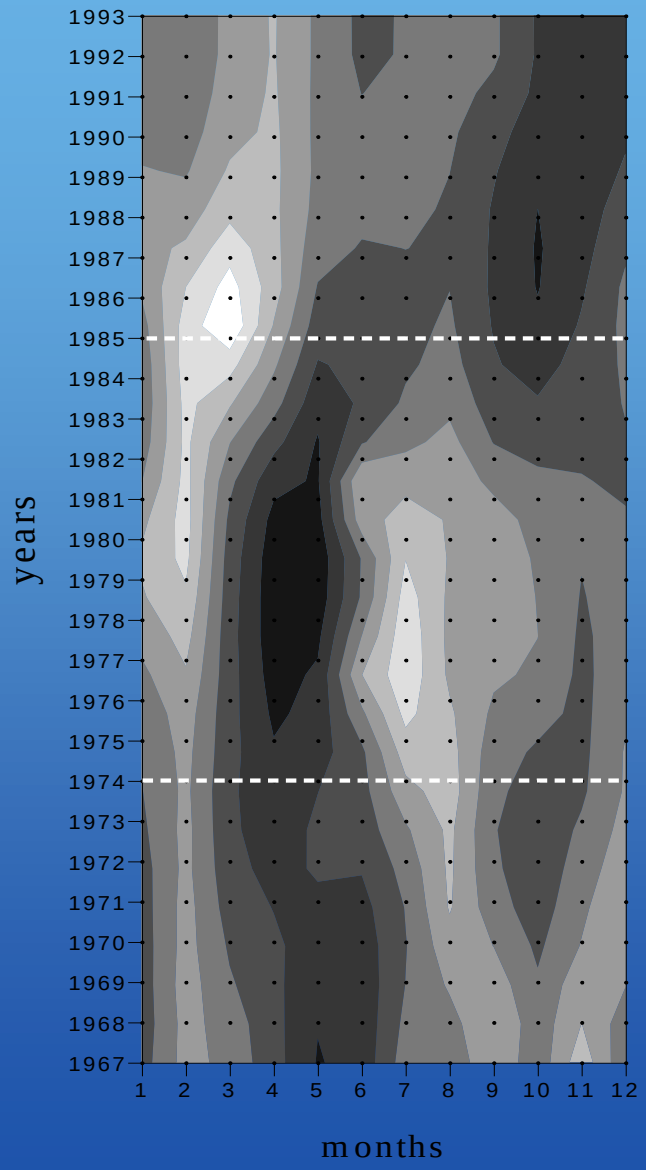
Anomalous changes in hydrology & gelatinous carns.



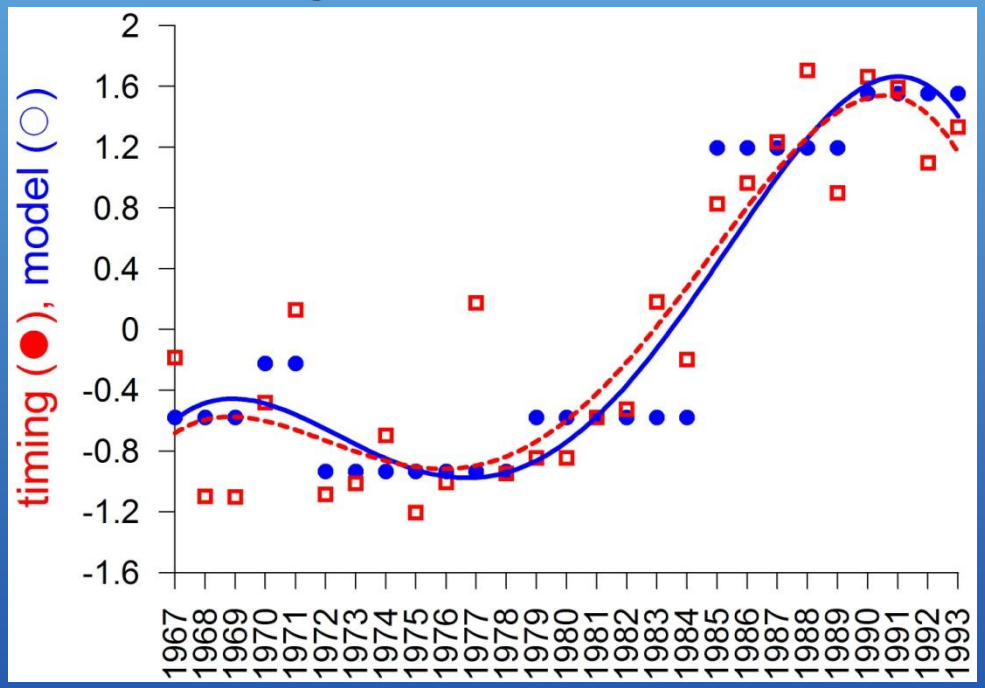
North Atlantic climate and gelatinous carnivores

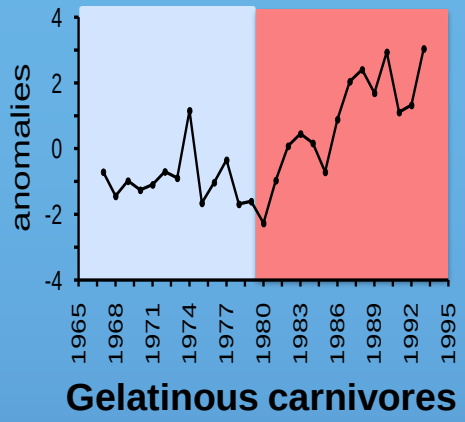


Phenological changes

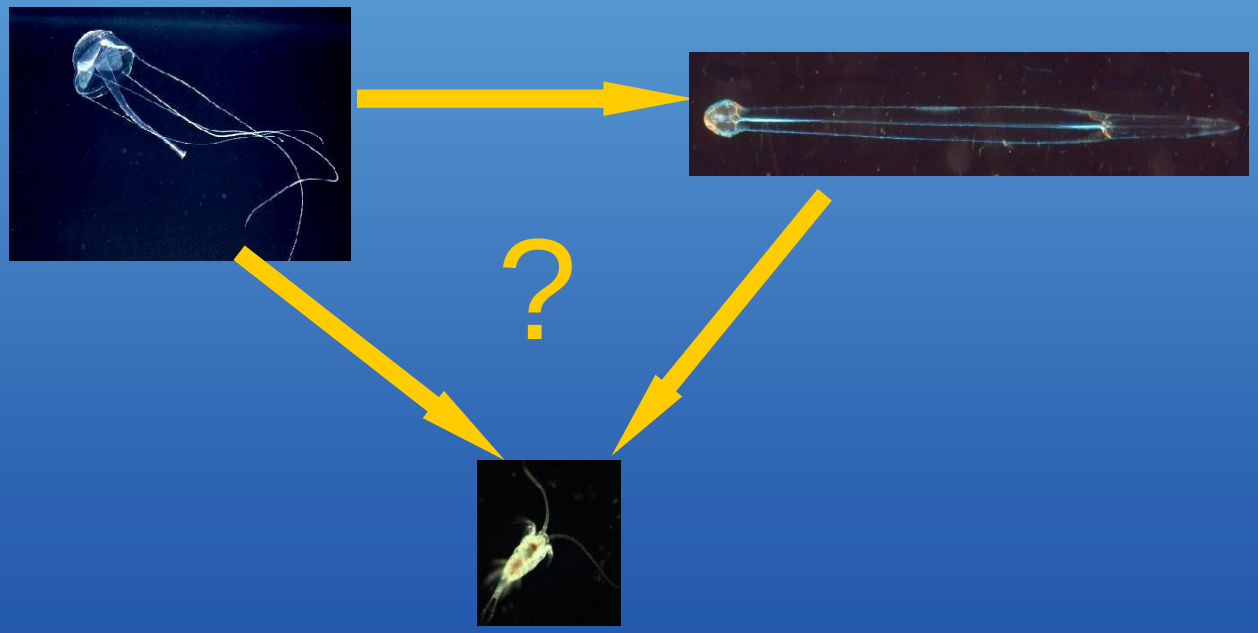


Water temperature & stability of the water column as proxies of phenological changes

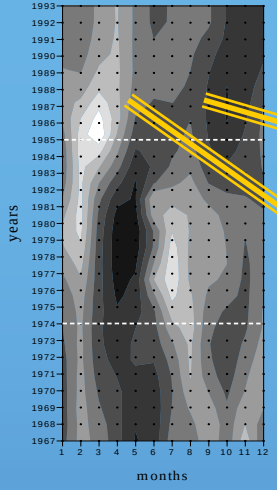




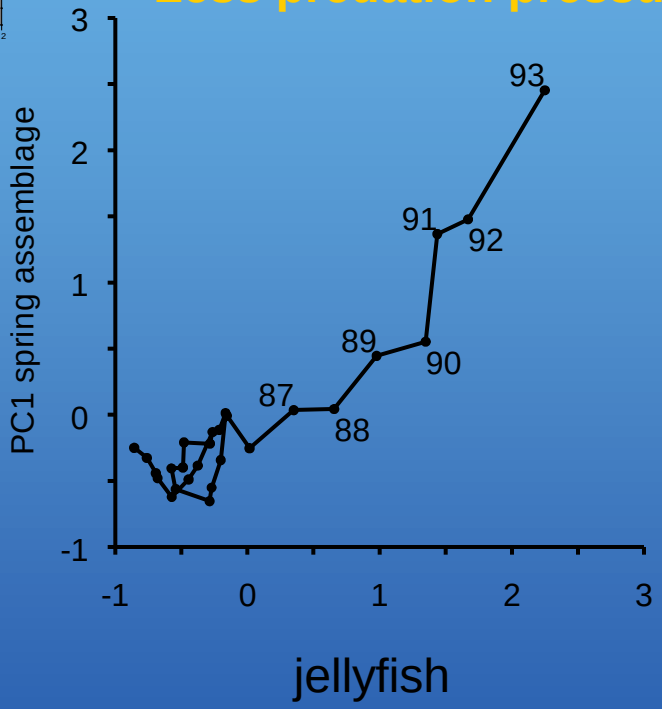
Ecological interactions



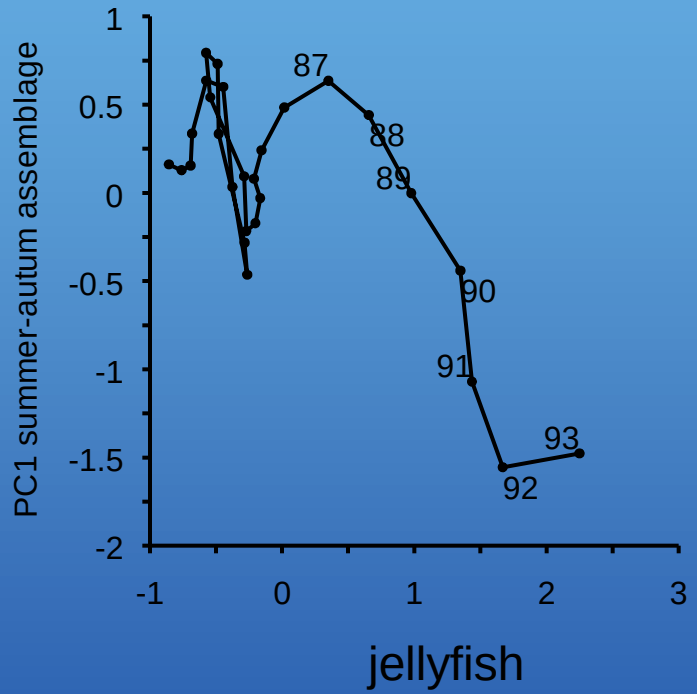
Potential changes in ecological interactions



Less predation pressure



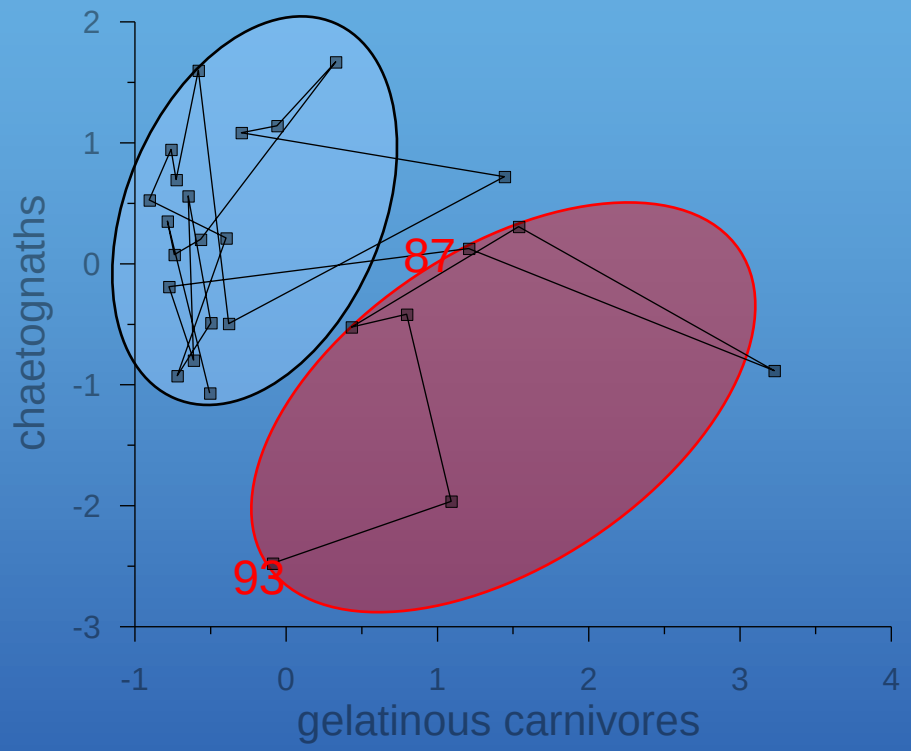
High predation pressure



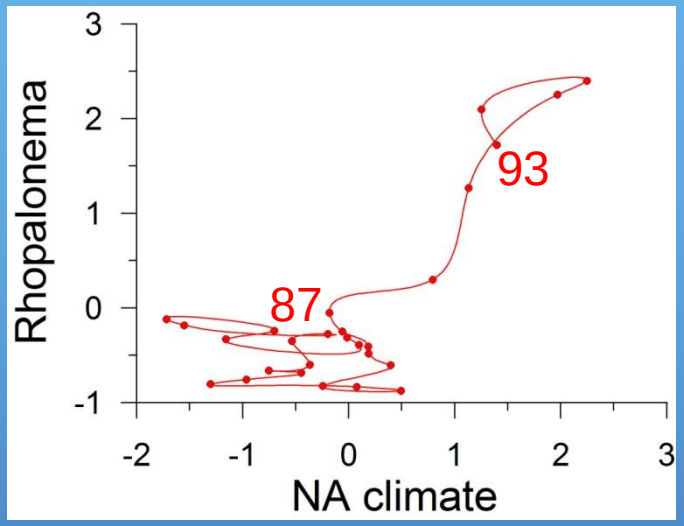
Spring copepods:
Centropages typicus
Acartia clausi
Calanus helgolandicus

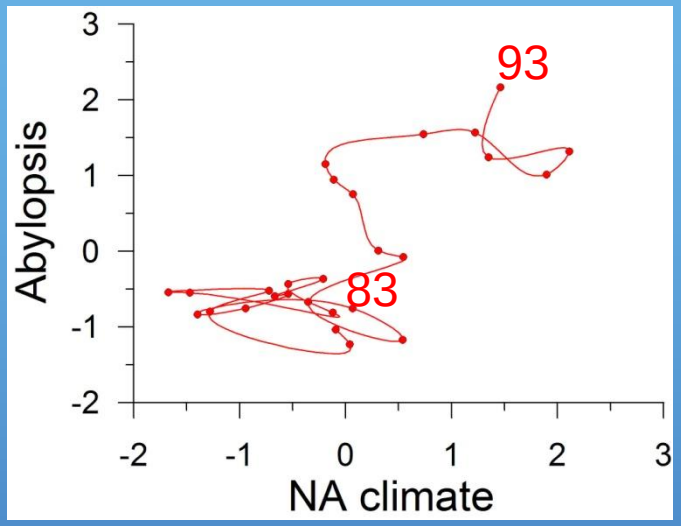
Summer-autumn copepods:
Temora stylifera
Oithona spp
Oncae spp
Calanus minor

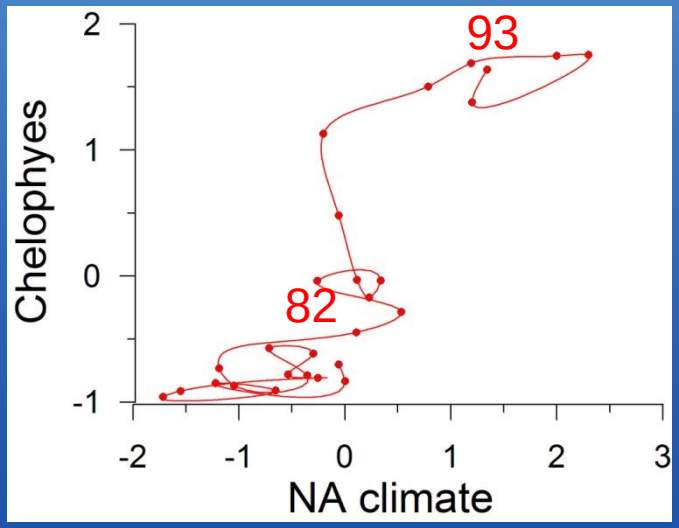
Potential changes in ecological interactions

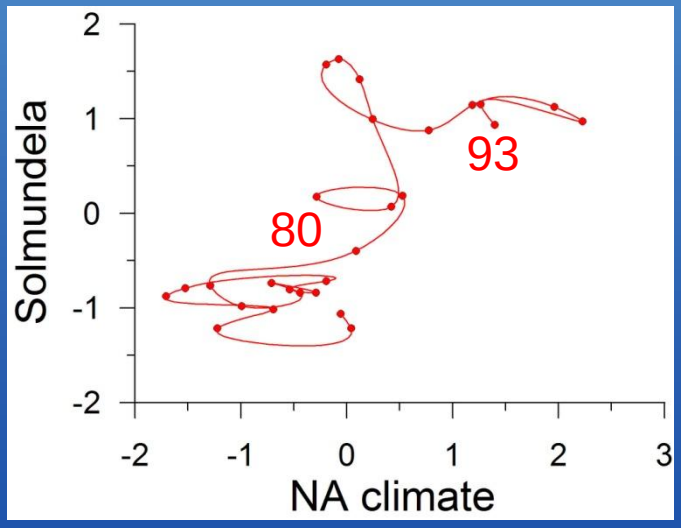


The variations are however species specific

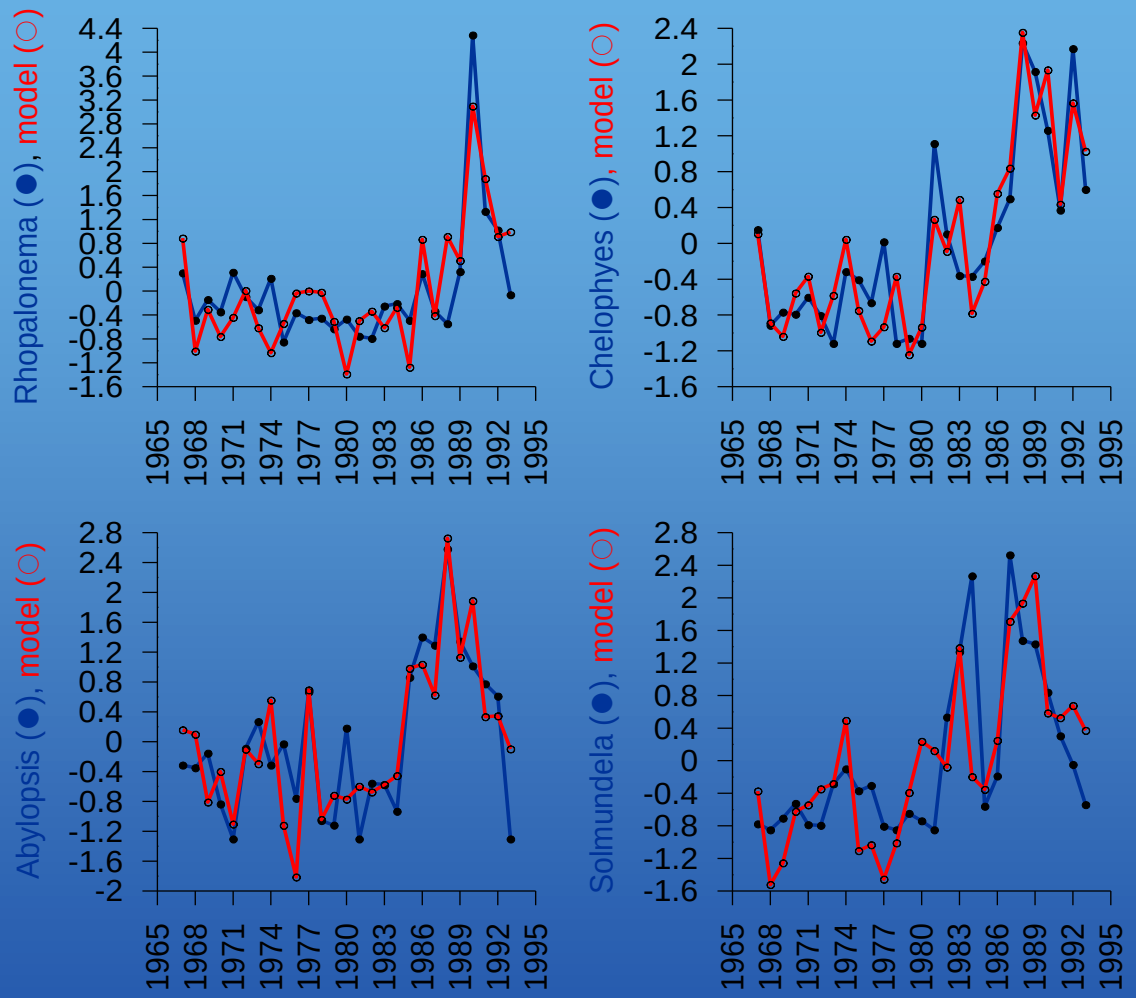








Assessment of the interannual variability by the downscaling approach



Water column stability and temperature preceding their seasonal peak appear as drivers of the inter-annual variations

Predictor	Predictand	CCA	CC	β
Climate	stratification	0.68	0.64	0.57
*Climate	stratification	0.75	0.72	0.55
Hydro-climate	timing	0.77	0.7	0.42
*Hydro-climate	timing	0.81	0.75	0.66
Hydro-climate	*Chelophyes*	0.72	0.63	0.4
*Hydro-climate	*Chelophyes*	0.8	0.72	0.64
Hydro-climate	*Abylopsis*	0.6	0.54	0.65
*Hydro-climate	*Abylopsis*	0.92	0.85	0.84
Hydro-climate	*Rhopalonema*	0.65	0.61	0.57
*Hydro-climate	*Rhopalonema*	0.84	0.75	0.71
Hydro-climate	*Liriope*	--	--	--
*Hydro-climate	*Liriope*	0.66	0.58	0.9
Hydro-climate	*Solmundela*	0.59	0.55	0.66
*Hydro-climate	*Solmundela*	0.71	0.65	0.5
Hydro-climate	*Pleurobrachia*	--	--	--
*Hydro-climate	*Pleurobrachia*	0.73	0.55	0.53

***denotes results for models built up when considering only years in which North Atlantic climate anomalies were higher than 1 standard deviation.**

Conclusions

➔ the **changes** in the **hydrological regime** noticed in the 1980s **allowed longer** and **more prolific** reproductive **seasons** for gelatinous carnivores

➔ If projections of **NA climate scenarios** are confirmed (i.e. dominance of the positive phase), our results **alert** on a recurrence of **gelatinous carnivores outbreaks** that **may become more frequent** in the NW Mediterranean

➔ It is suggested the **possibility of assessing** interannual **abundance** changes of **these organisms** in the NW Mediterranean **according to the NA climate variability**

➔ These results constitute **ecological warning indicators** of substantial changes in the **pelagic ecosystem** of the Northwestern Mediterranean.

Thank you