Contract: WP4-SYSMS-1101

Long term copepod variability in the coastal Ligurian and Tyrrhenian seas (Mediterranean)

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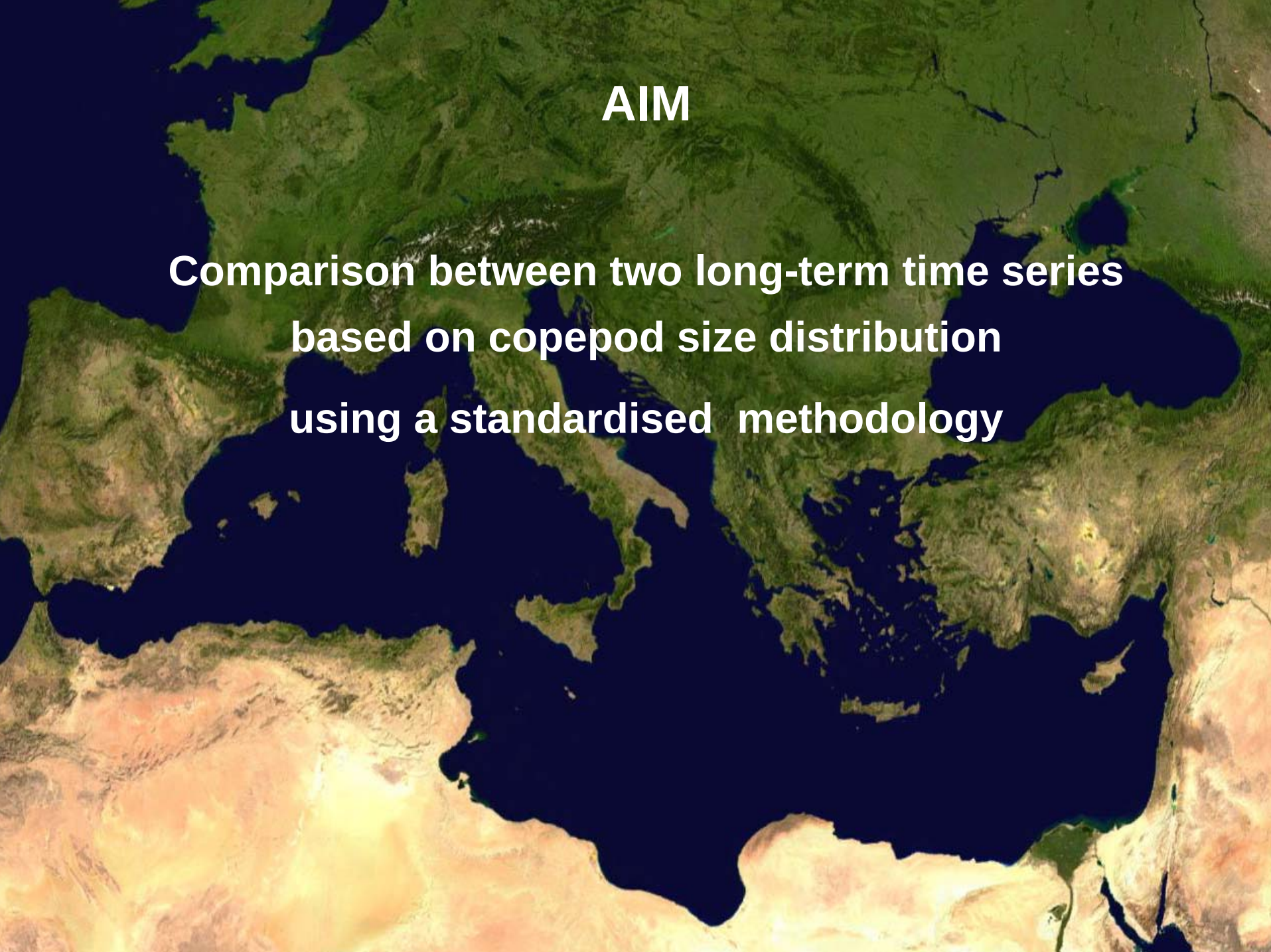
Why the Mediterranean Sea?

It is an enclosed sea functioning as a small ocean.

Its sub-basins are very sensitive to climate forcing.

Long term datasets are available and can be compared.



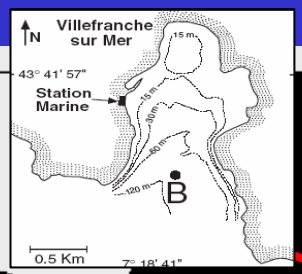
AIM

Comparison between two long-term time series based on copepod size distribution

using a standardised methodology

Sampling Sites

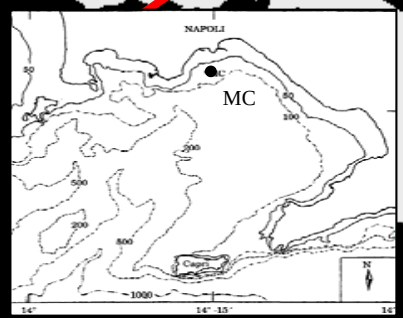
- **St.MC (Gulf of Naples, Tyrrhenian Sea) *from 1984 onwards***
- **Point B (Villefranche Bay, Ligurian Sea) *from 1966 onwards***



Weekly sampling

Vertical hauls (70-0m)

JB net (330 μm mesh)



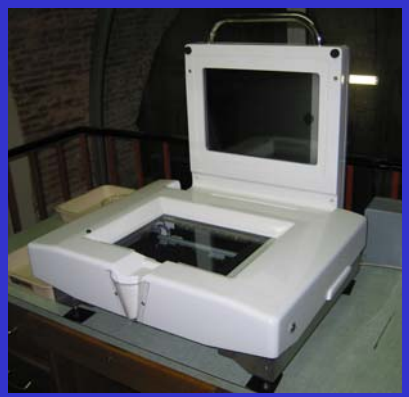
Weekly sampling

Vertical hauls (50-0m)

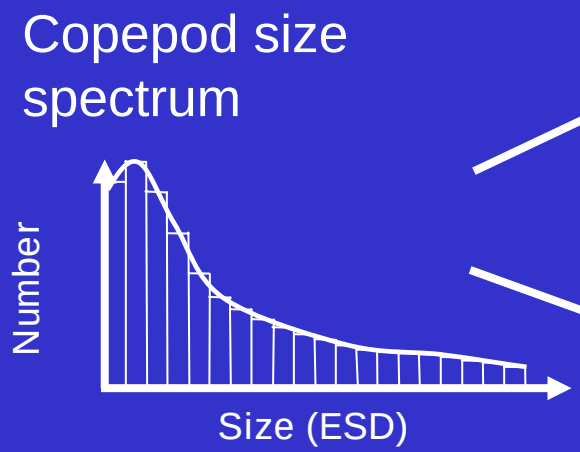
Nansen net (200 μm mesh)

Methodology: **The Zooscan**

- Harmonisation of both time-series
- Copepod automatic Identification (recall 93%, precision 84%)
- Size as a community descriptor



Digitalisation of >550 samples with the ZOOSCAN



Total copepod abundance

Diversity of size classes

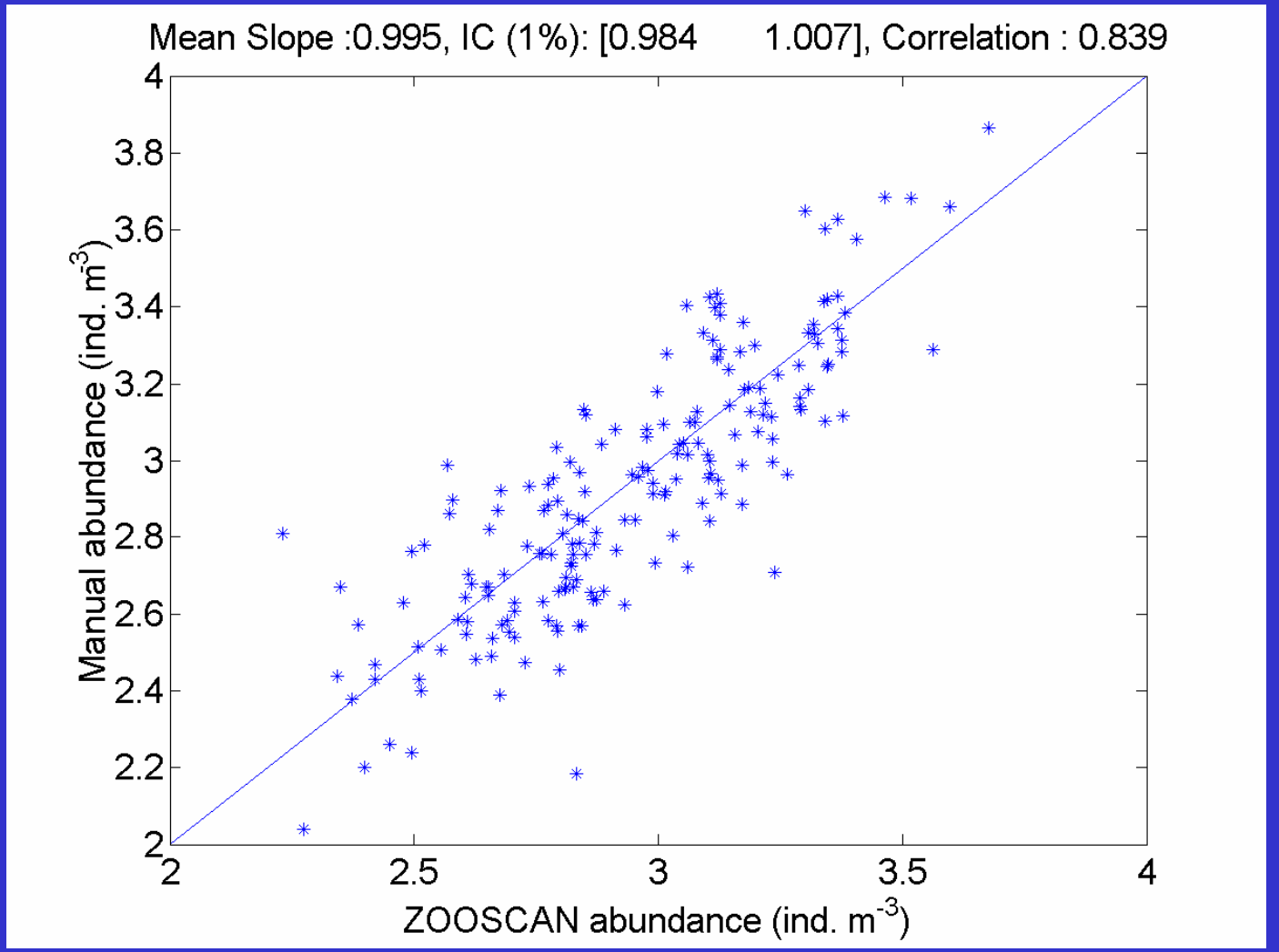
Shannon index

(Parson, 1969, Ruiz, 1994)

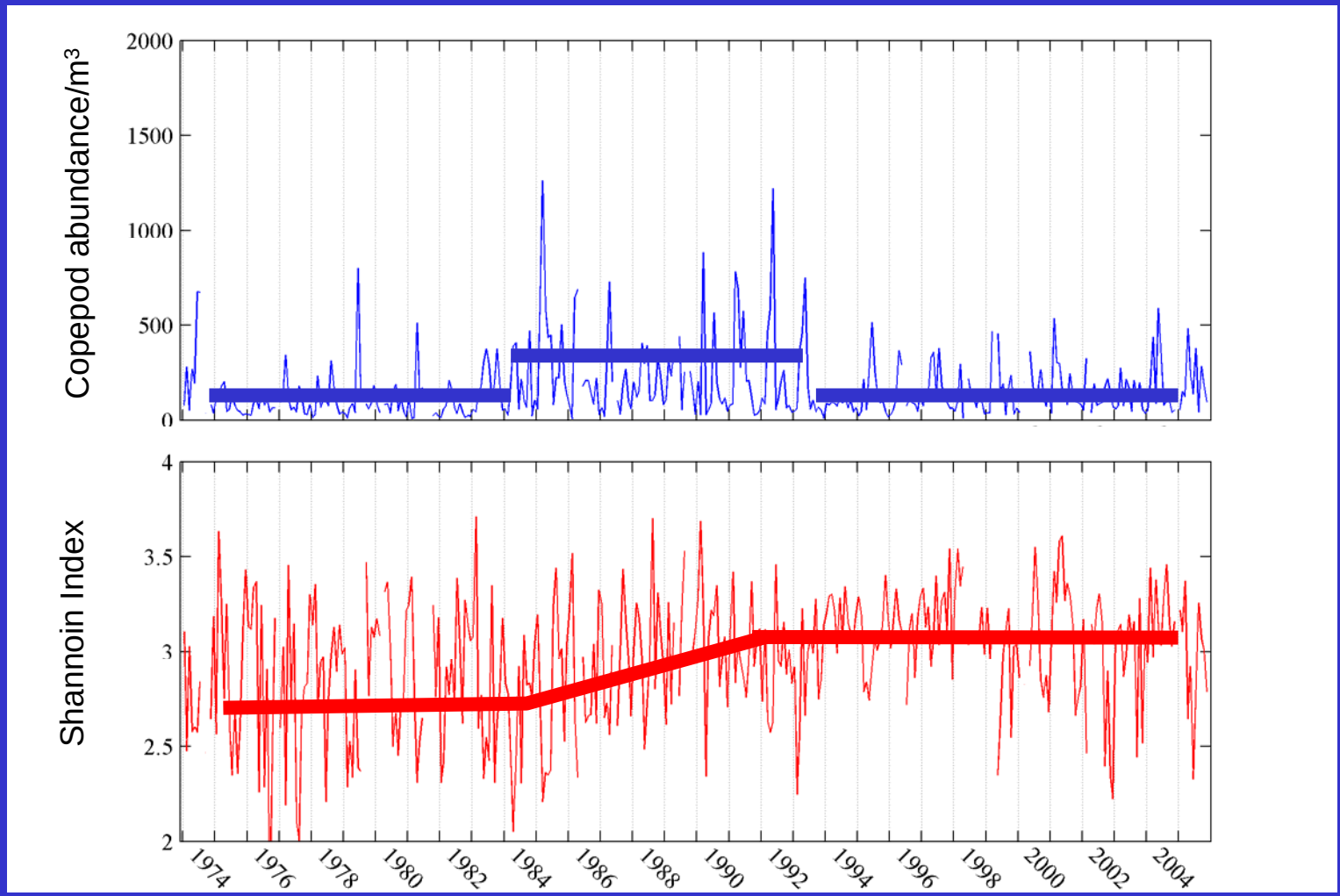
1 Size class ~ 1 Species

$$H' = -\sum p_i \log_2 p_i$$

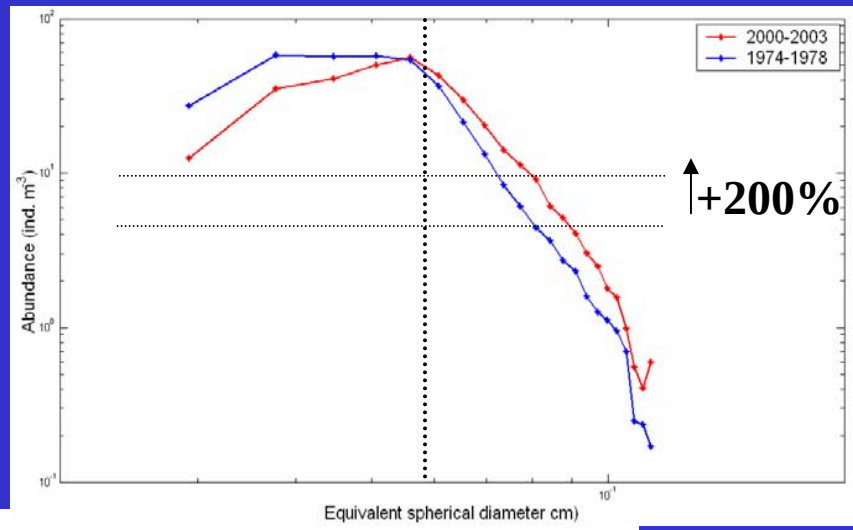
Automatic and Manual counts comparison (Naples time series)

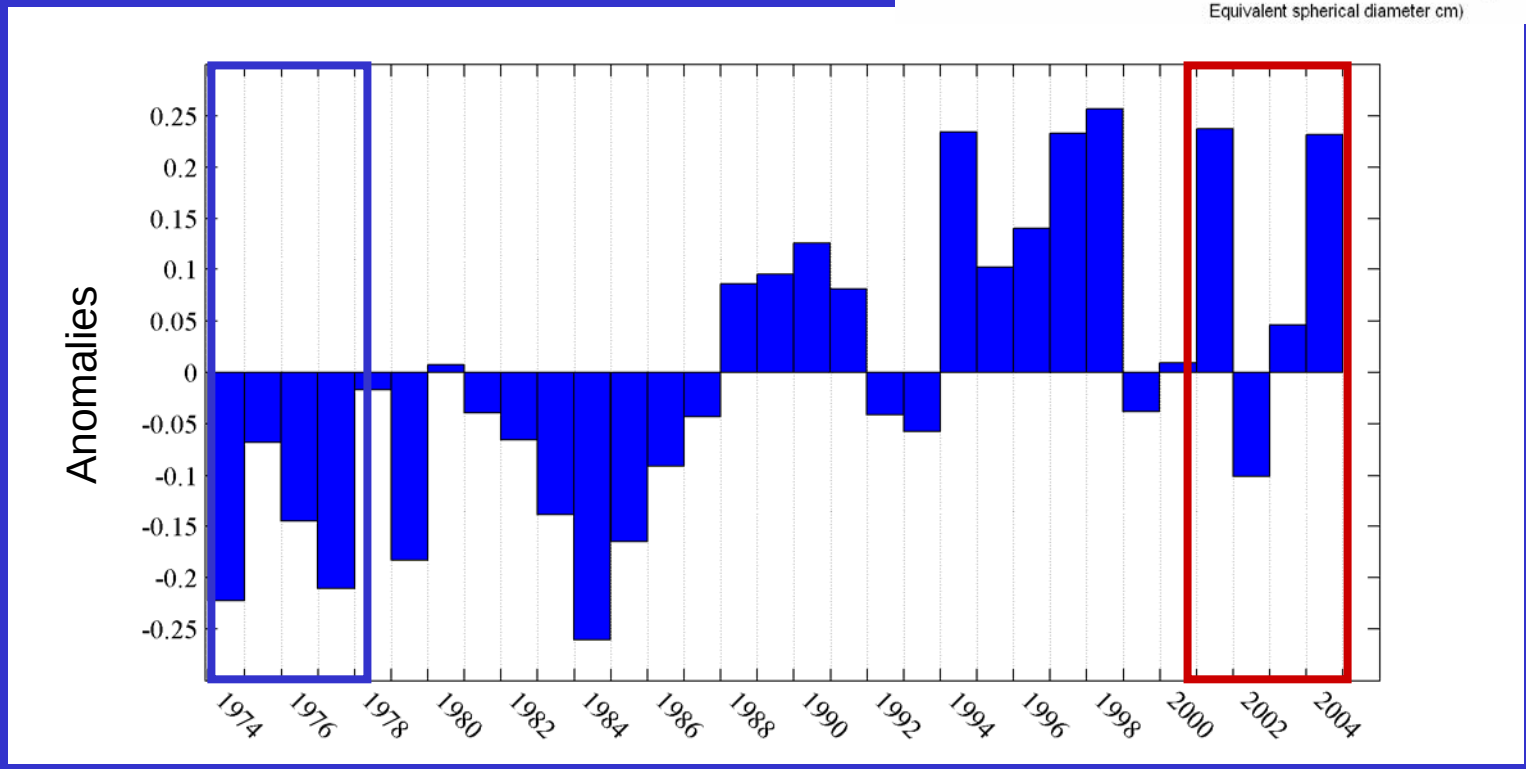


Villefranche Copepod Abundance and Size Diversity
(raw data)



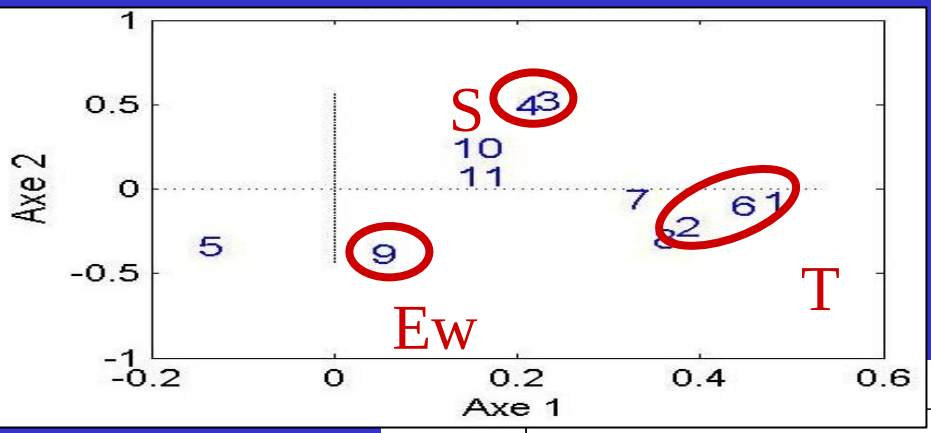
Size Diversity





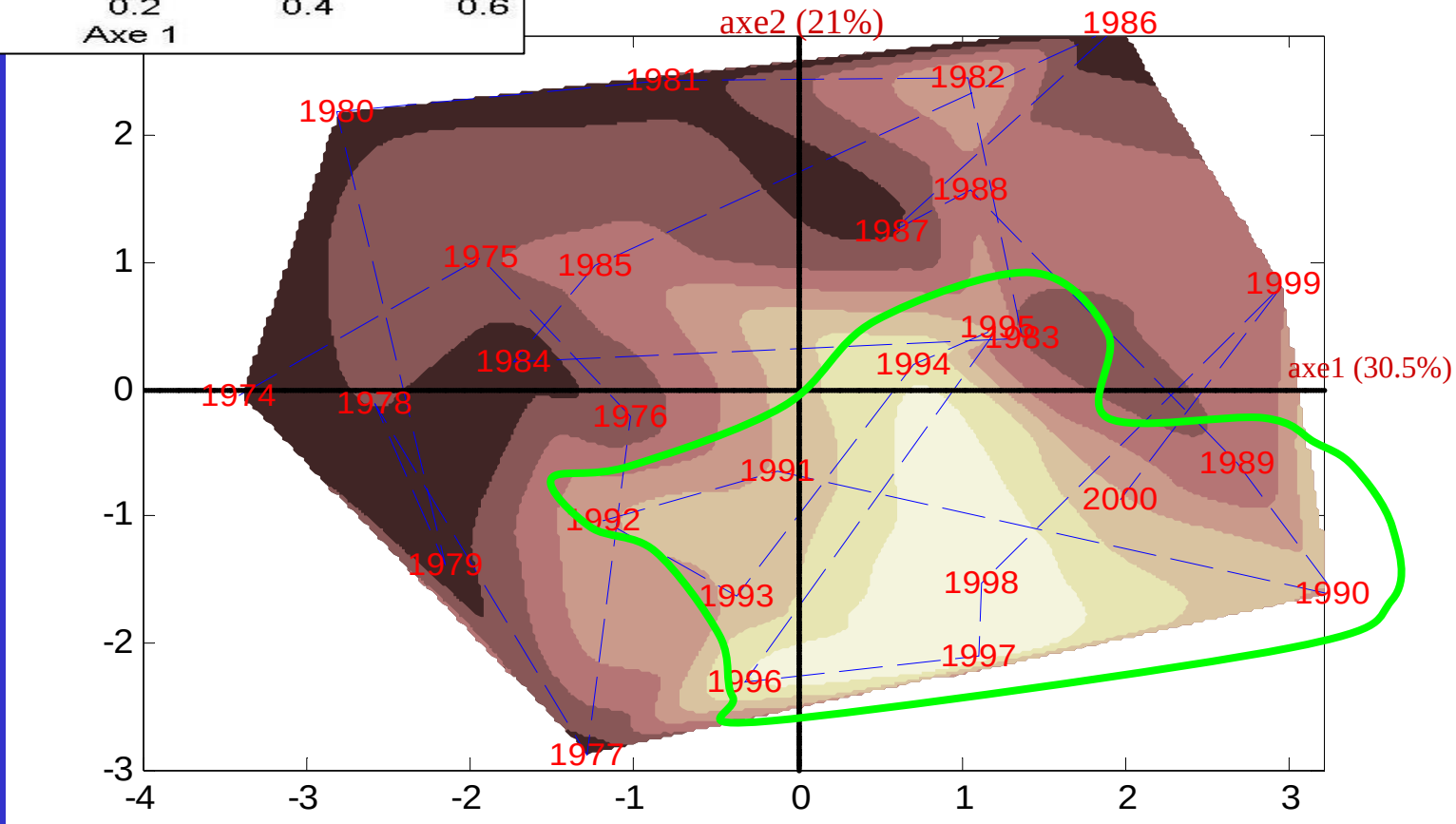
Environmental variables' PCA

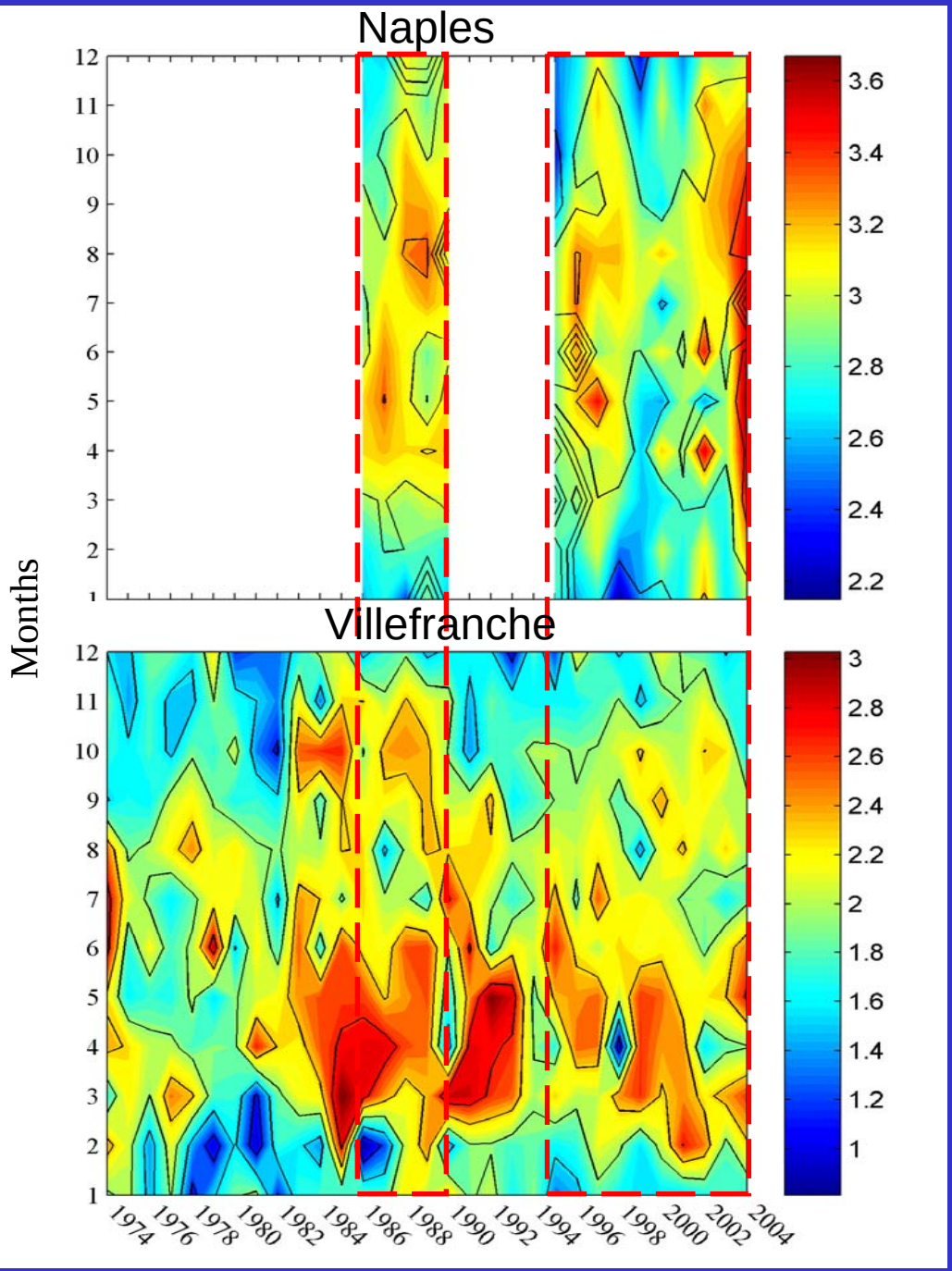
(*Principal Component analysis*)



C1 = 30.5% of the variance

C2 = 21% of the variance





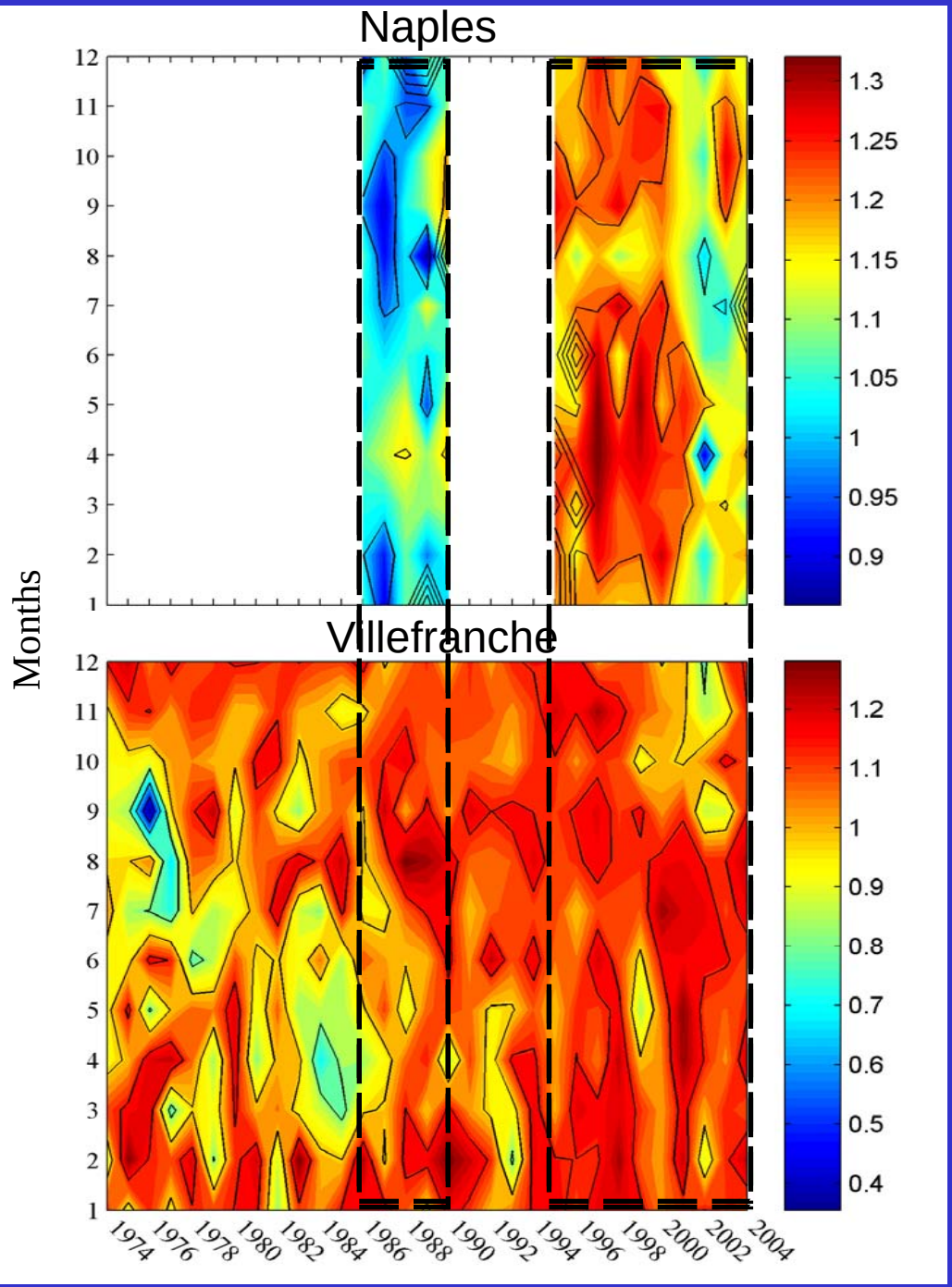
INTERCOMPARISON

Abundance

1) Villefranche earlier spring peak.

2) Naples highest abundances in summer.

3) In Villefranche the periods with or without autumnal peaks alternate.



INTERCOMPARISON

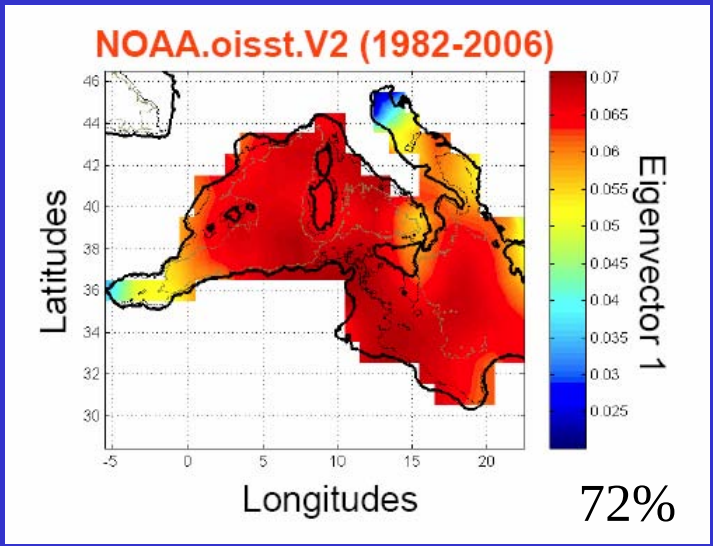
Size Diversity

1) Expected smaller mean size at the bloom.

2) Summer opposite patterns.

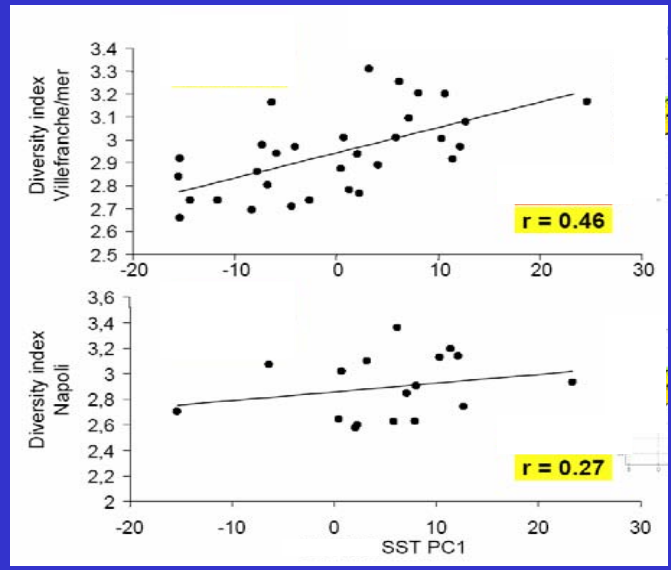
3) Interannual trend of increasing mean size for both time series until 2000, from 2000 it decreases in Naples.

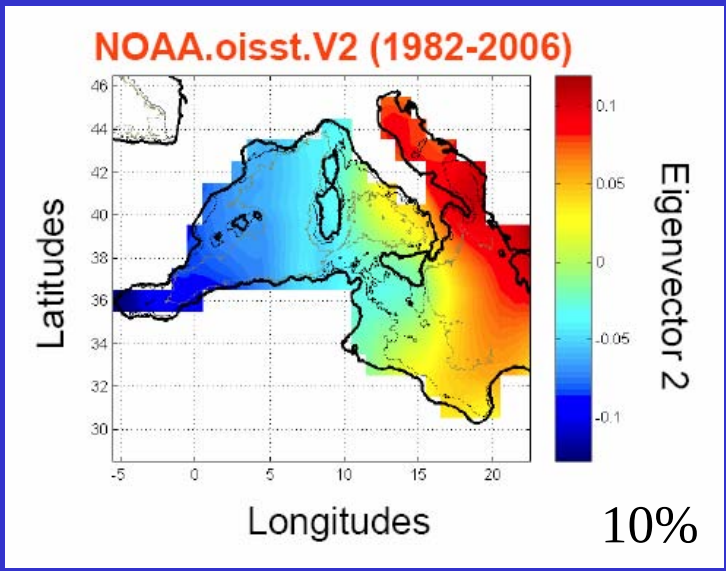
Relationship with basin scale climate (SST)



1st axe:
Global warming of the basin.

More correlated to size diversity in Villefranche.

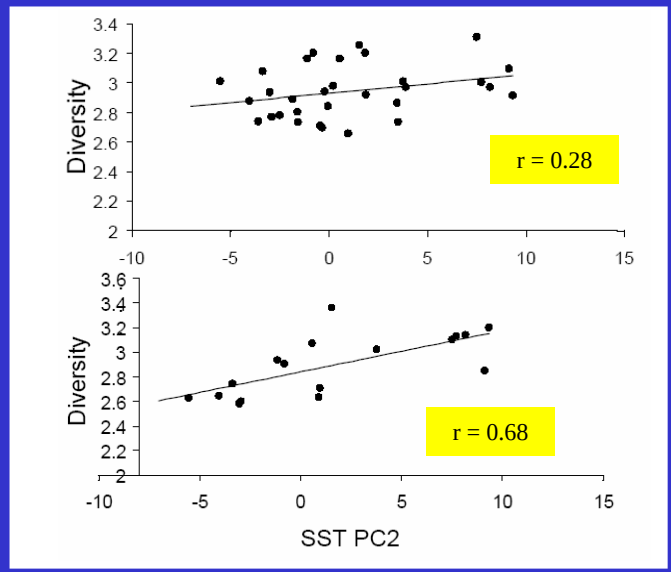




2nd axe:
Differences between the east and west part of the basin.

Naples at the boundary.

Local influence on the size distribution in Naples.



Concluding remarks

- In Villefranche, the shift toward larger copepod size classes from 1987 may be probably linked to the arrival of larger open ocean populations driven by the more frequent eastern winds.

- The two sites show different trends and seasonality.

- Naples station is located in a climatological boundary and its size diversity changes seem to be more related to local changes.

- The standardised approach and use of size diversity is a promising tool for long term ecosystem monitoring.

The French – Italian collaboration may be seen as a part of a larger project which is actually undertaken in the framework of the SESAME European program which includes the Mediterranean and Black seas.

Thanks to...

ICES
Eur-oceans
CNR and Egide program
The crews of both sampling sites
SOMLIT monitoring program
NOAA (National Oceanographic and atmospheric administration)

Iole di Capua
Lionel Guidi

Thank you for your attention!!!

Extras

Dataset

Point B time series (France): *1974-2000*

- Monthly Copepod abundance and Size diversity
- Water T and salinity
- Chla and nutrients (from 1991)
- Air T, wind pattern, precipitation , atmospheric pressure and irradiance

MC timeseries (Italy): *1984-2005*

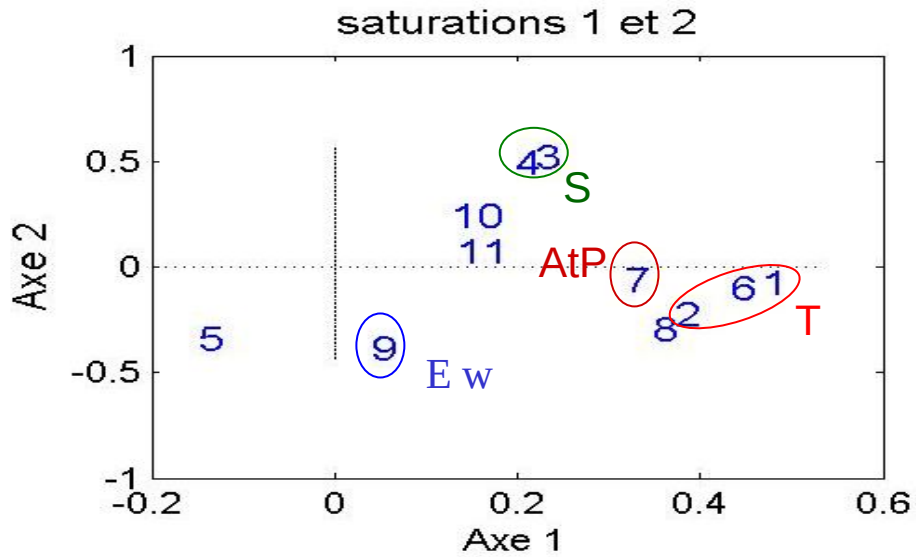
- Monthly Copepod abundance and Size diversity
- Taxonomic counts
- Water T, salinity and Chla

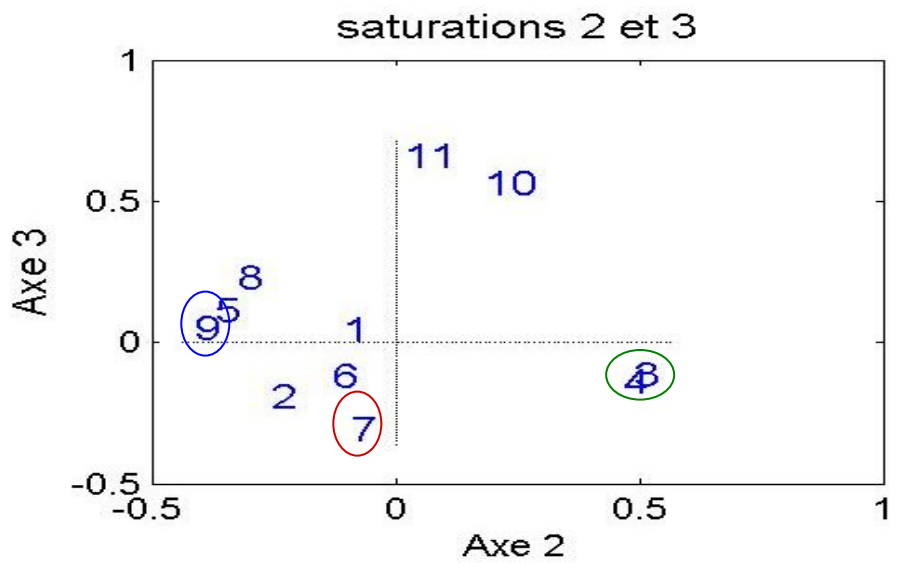
NOAA (National Oceanographic and atmospheric administration)

- Mean SST (1982-2006)

Environmental variables' PCA

(*Principal Component Analysis*)





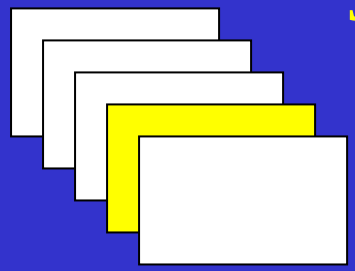
1:Temperature (20 m. depth)
2 : Temperature (50 m. depth)
3 : Salinity (20 m. depth)
4 : Salinity (50 m. depth)
5 : Rainfall
6 : Air Temperature
7 : Atmospheric pressure
8 : Ekman depth
9 : East wind (N days/month)
10 :South West wind
11 :North/North West wind

C1 = 30.5% of the variance

C2 = 21% of the variance

C3 = 16% of the variance

Copepod recognition



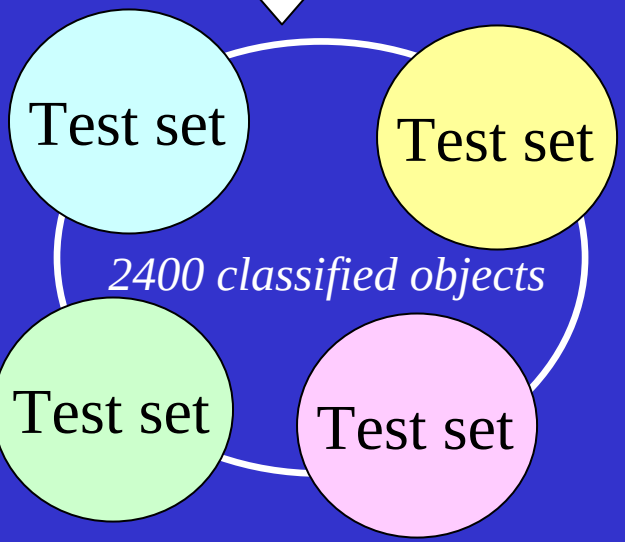
93% Copepod recognition

84% precision

1st Step

Confusion matrix

Definition of groups by cross-validation



2nd Step

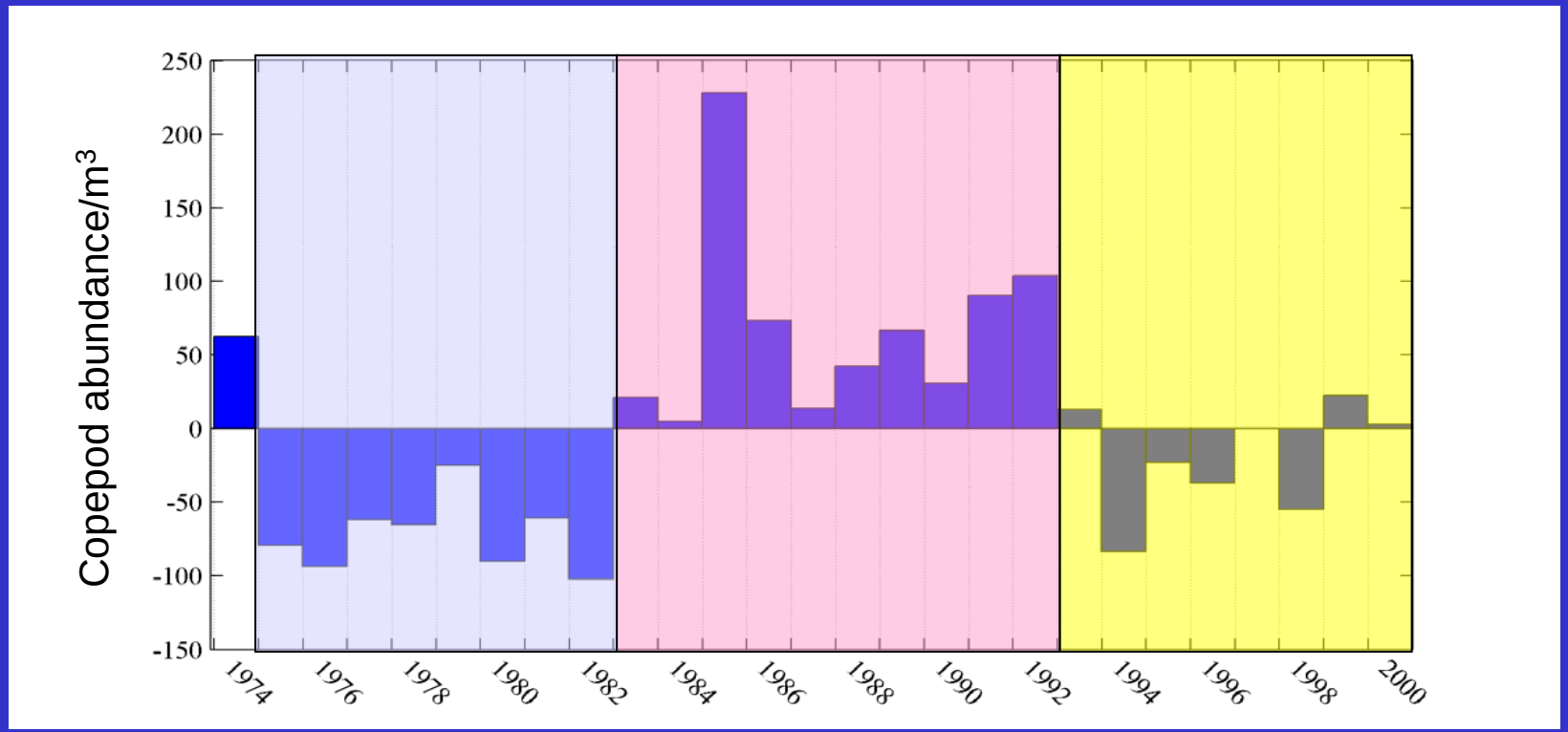
A controller avec ELVIRE !!

Learning set validation

SpvLearning method selection

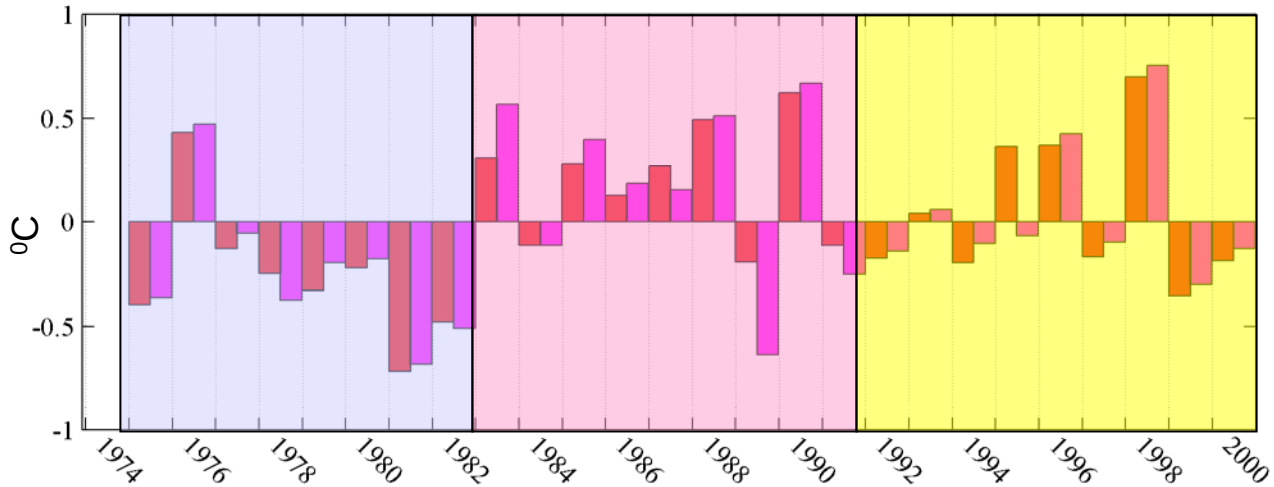
Copepod Abundance

Anomalies around the mean

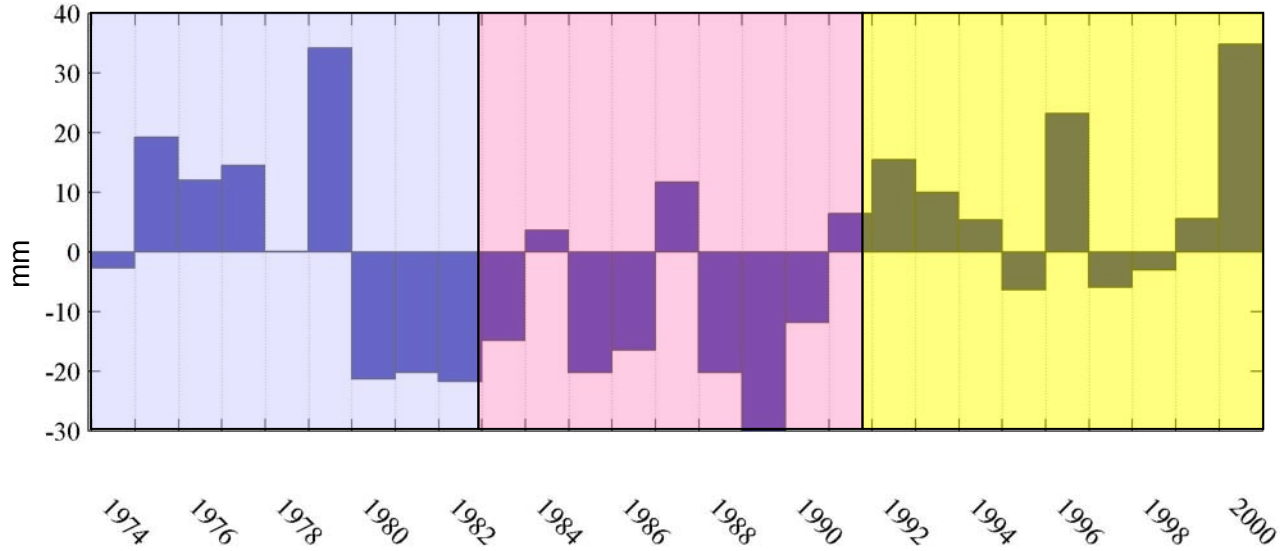


3 periods empirically distinguised

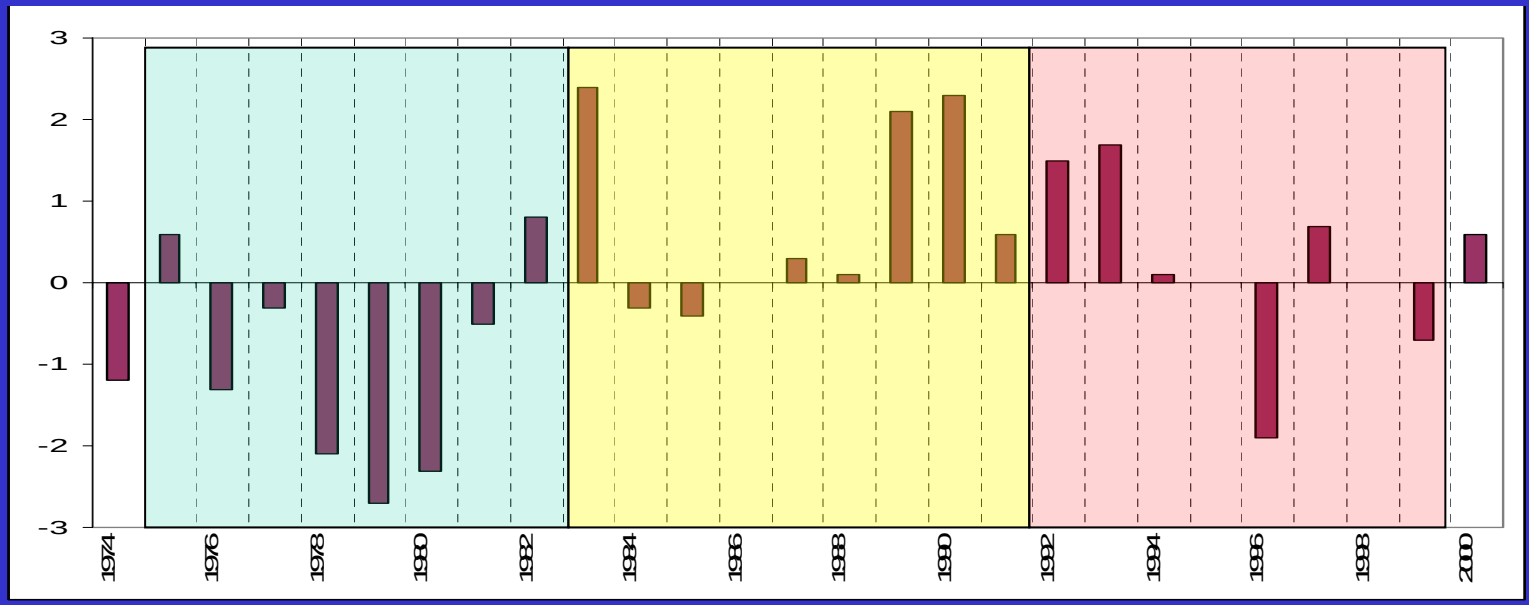
Winter Water Temperature at 20 and 50 m



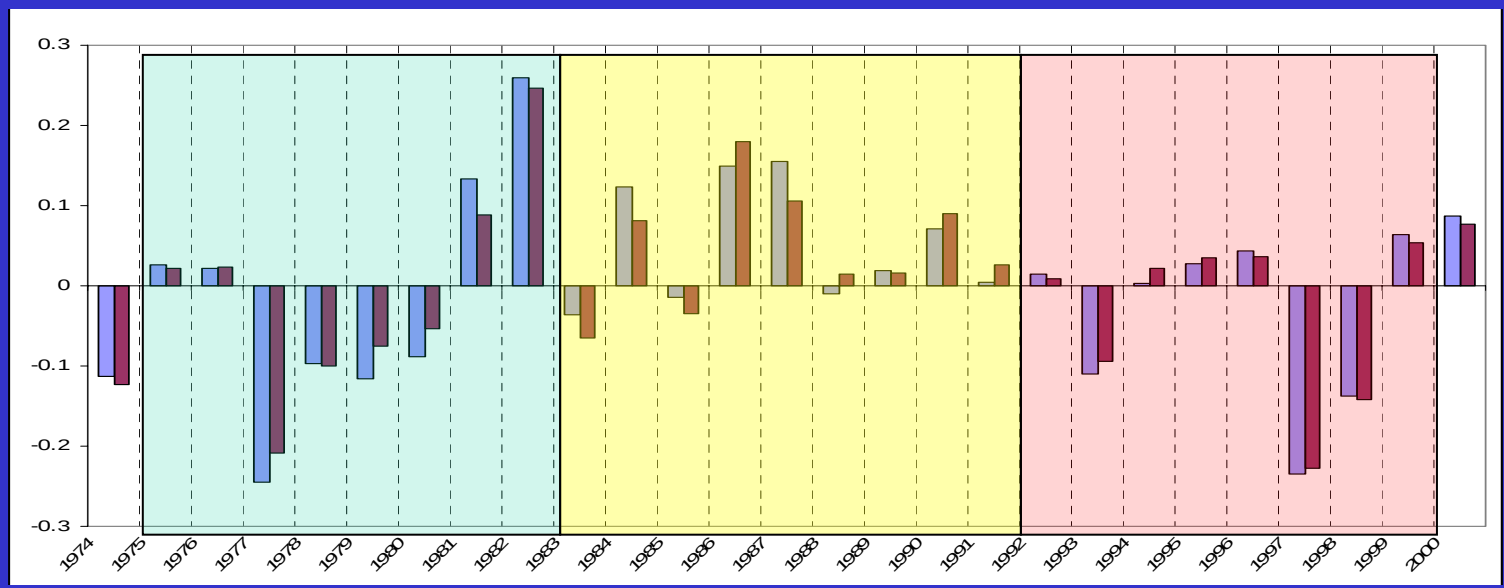
Rainfall



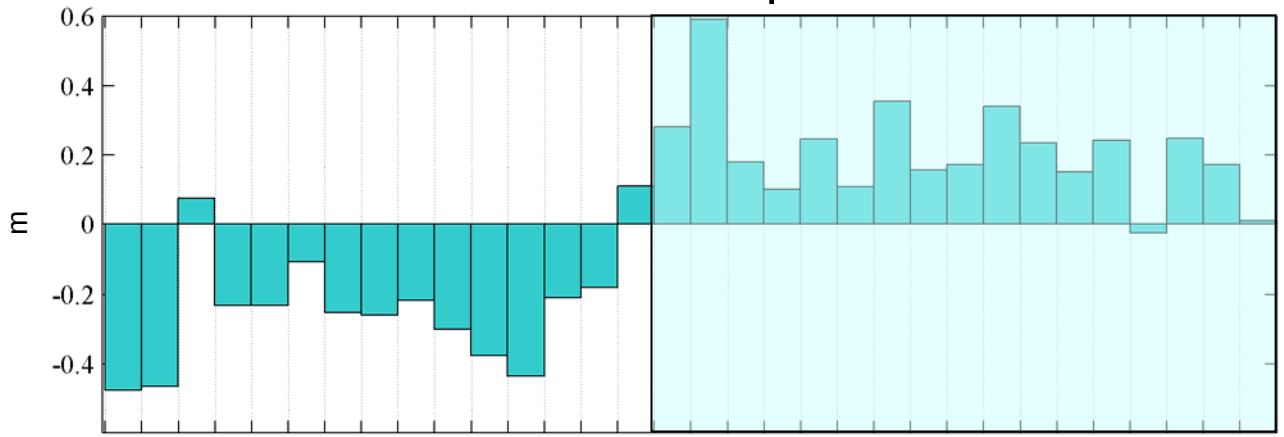
Atmospheric pressure



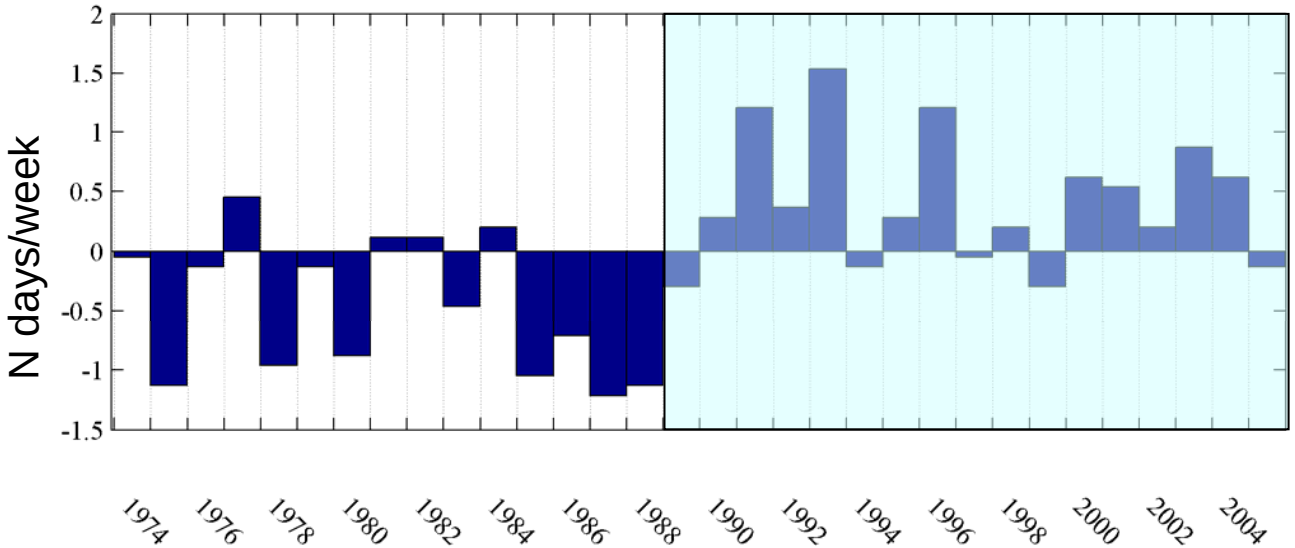
Winter Salinity at 20 and 50 m

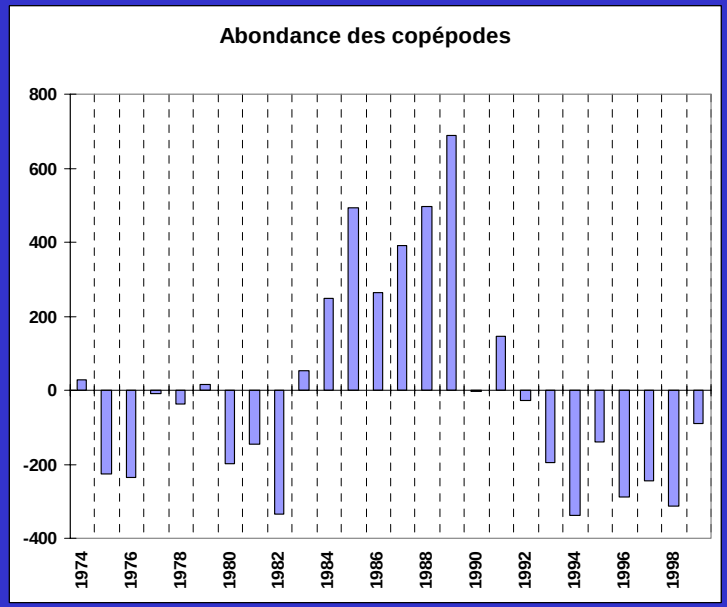


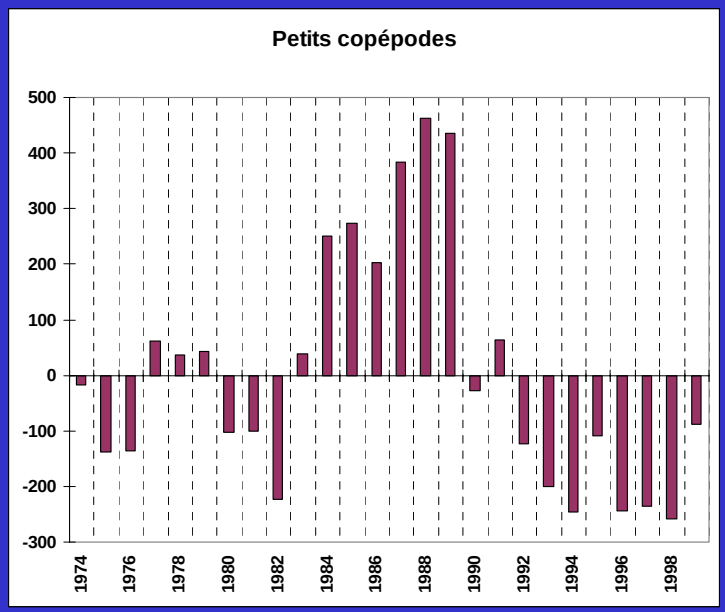
Ekman's depth

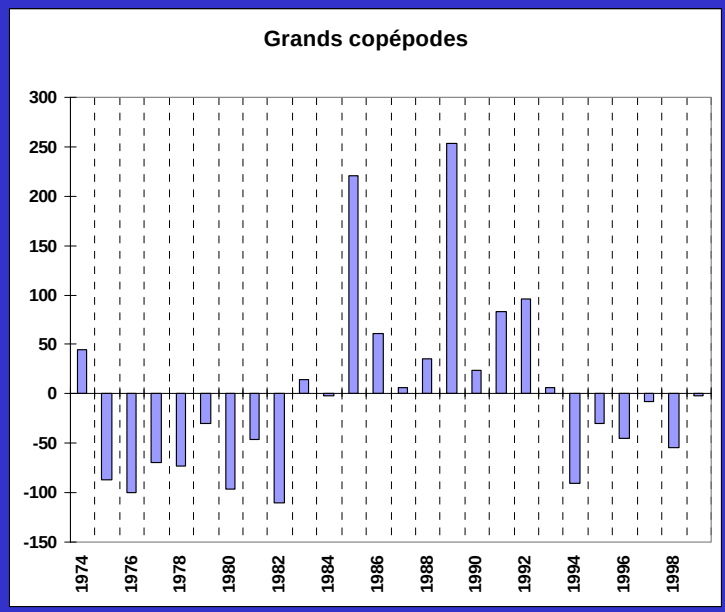


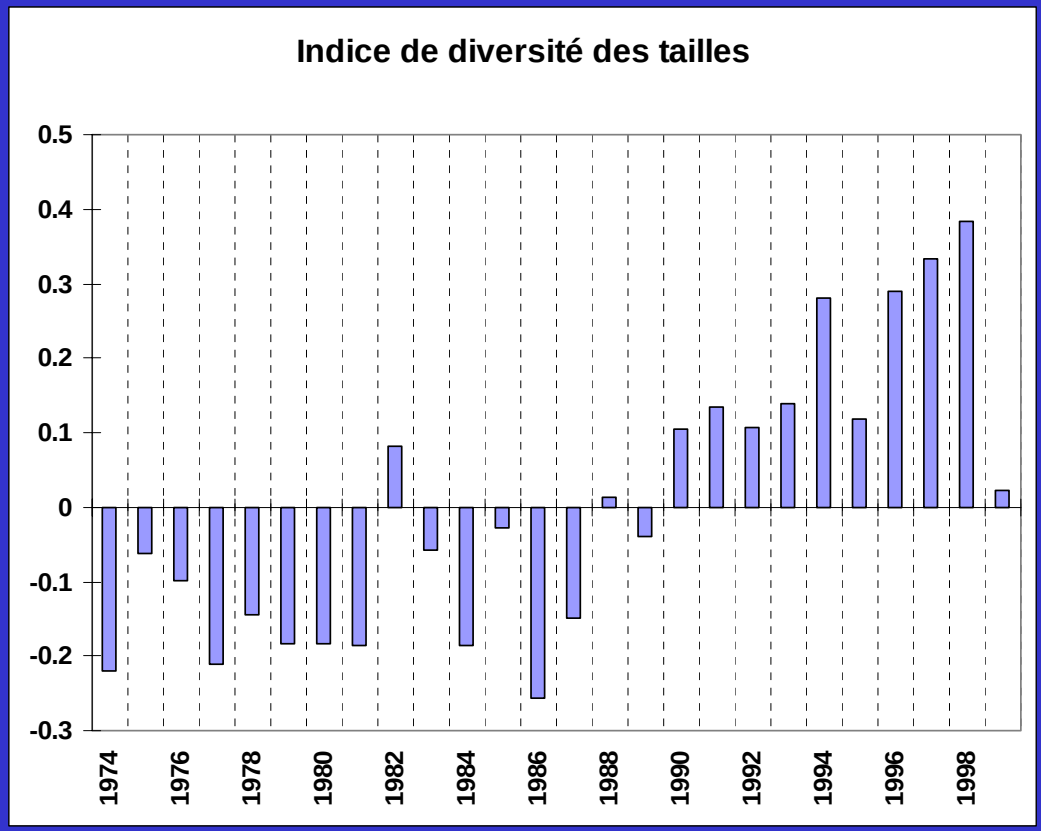
East Wind



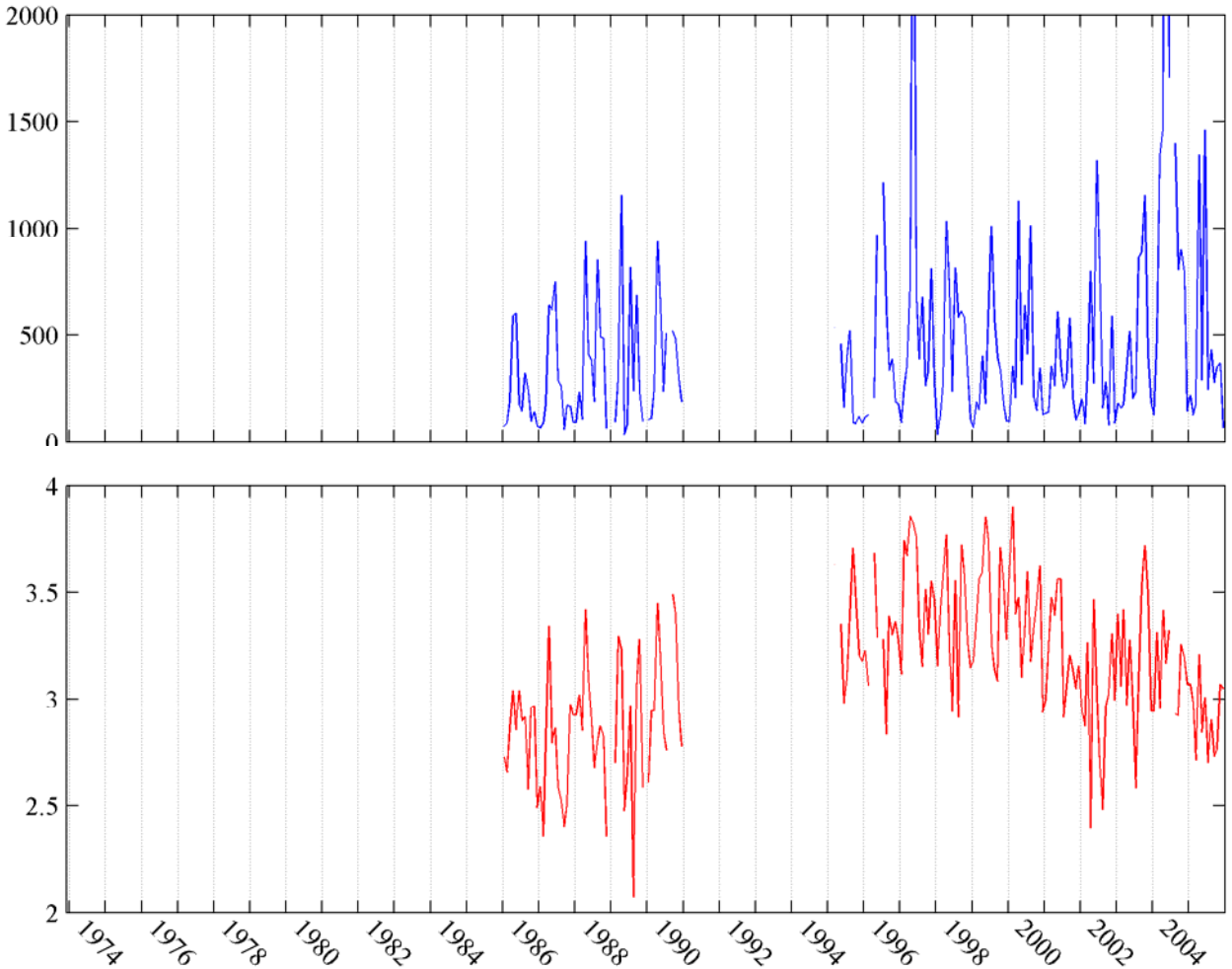

Abondance des copépodes
800
600
400
200
0
-200
-400
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998


Petits copépodes
500
400
300
200
100
0
-100
-200
-300
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998

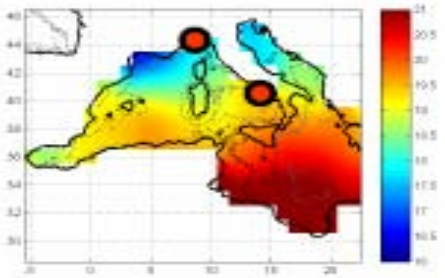

Grands copépodes
300
250
200
150
100
50
0
-50
-100
-150
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998


Indice de diversité des tailles
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998

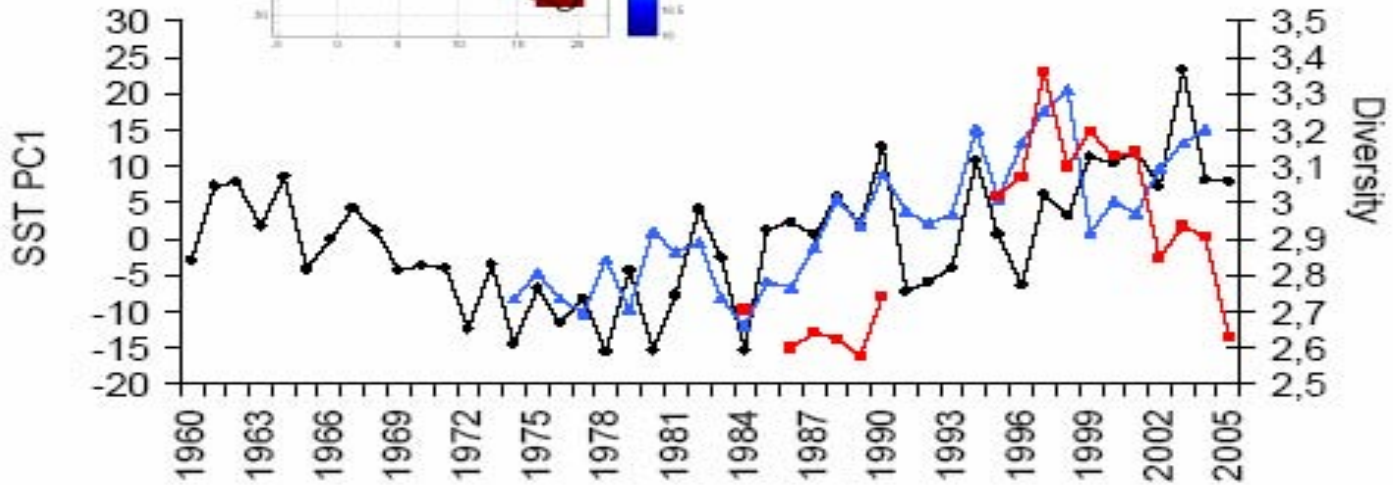
Naples time series (raw data)



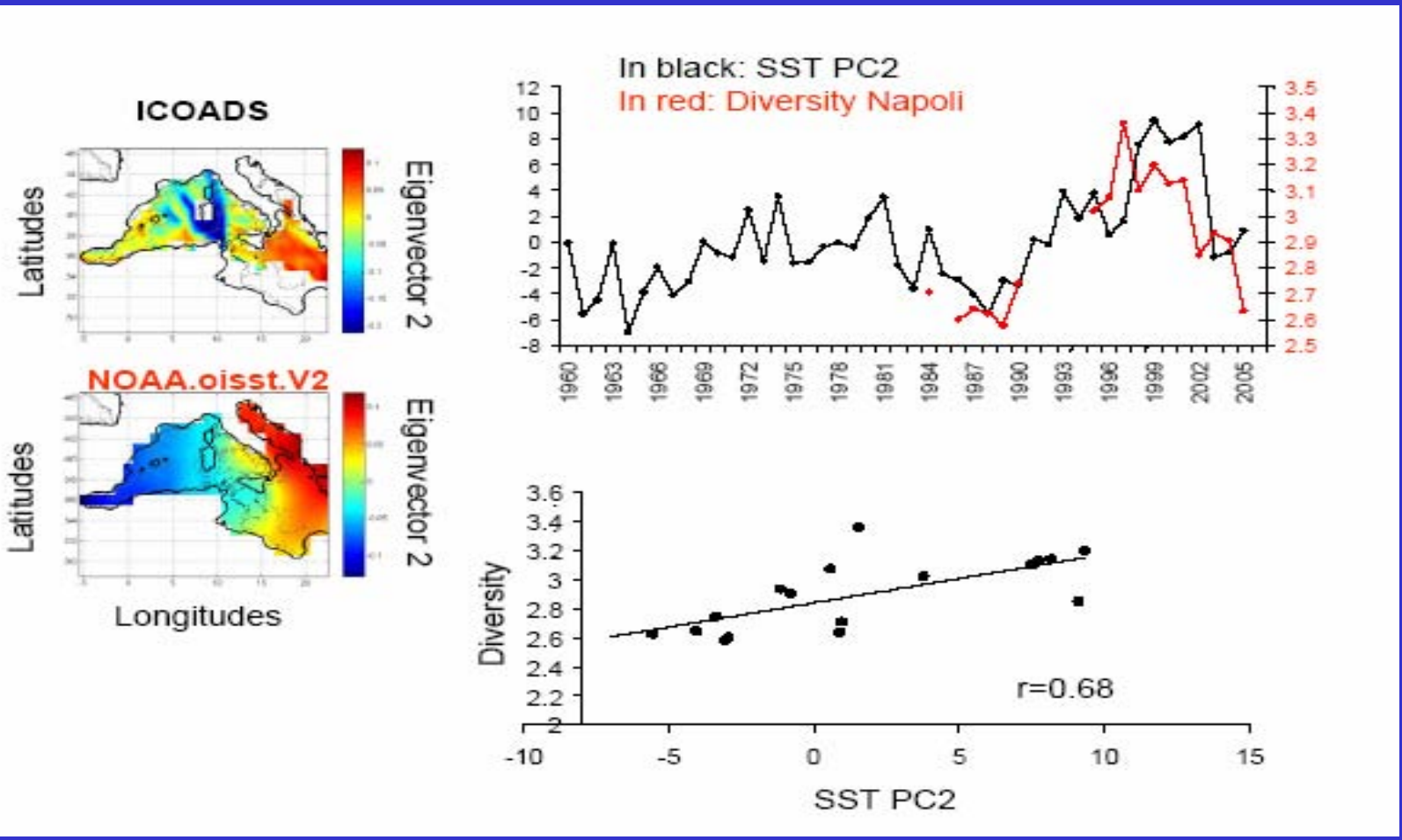
Diversity and SST changes (first mode or PC1)

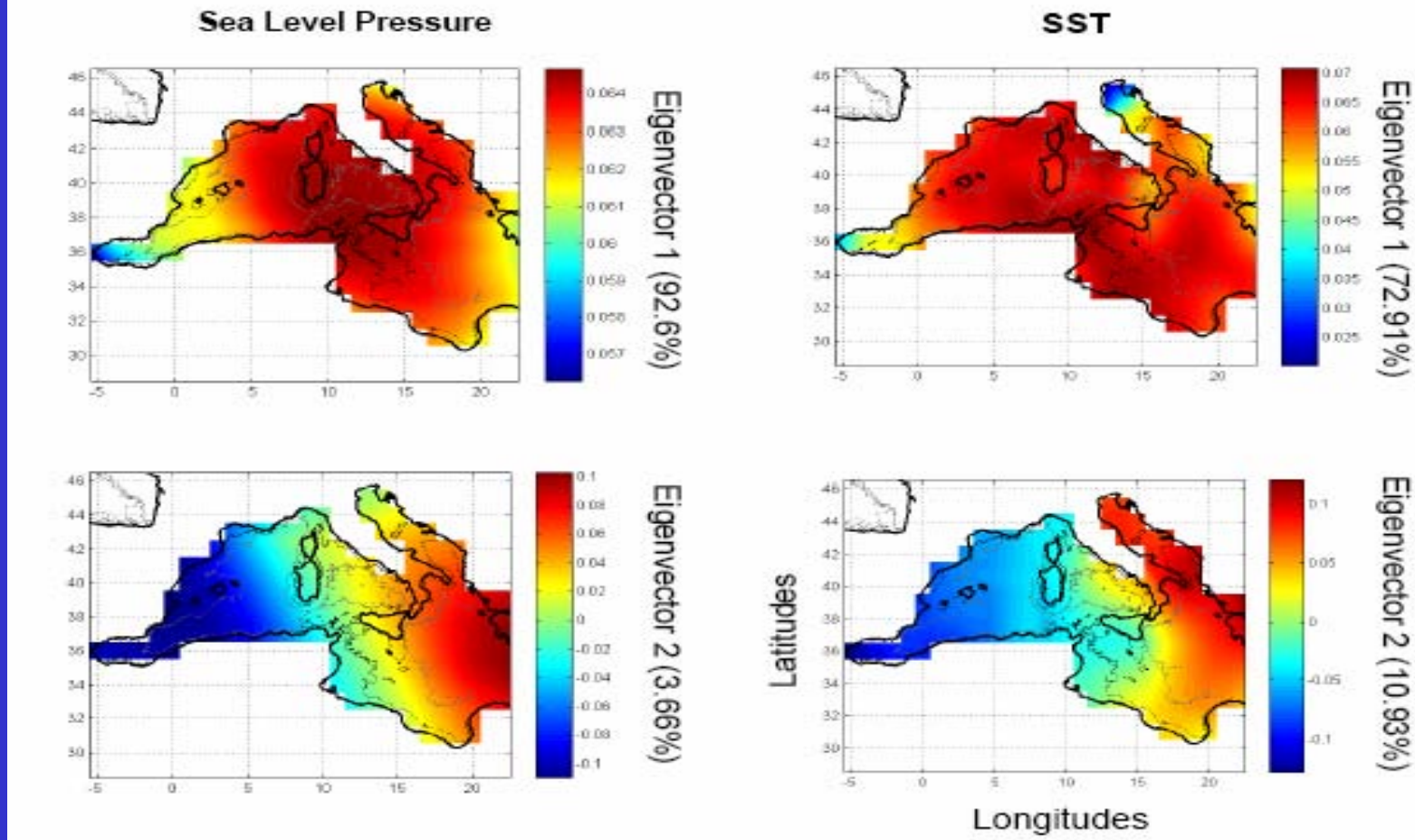


In black: SST PC1
In blue: diversity Villefranche
In red: diversity Napoli



Clear relationship at Villefranche and no relationship at Napoli


ICOADS
Latitudes
Eigenvector 2
NOAA.oisst.V2
Latitudes
Eigenvector 2
Longitudes
In black: SST PC2
In red: Diversity Napoli
12
10
8
6
4
2
0
-2
-4
-6
-8
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Diversity
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
r=0.68
-10
-5
0
5
10
15
SST PC2


Sea Level Pressure
SST
Eigenvector 1 (92.6%)
Eigenvector 1 (72.91%)
Eigenvector 2 (3.66%)
Eigenvector 2 (10.93%)
Latitudes
Longitudes