Are the outbreaks timing of *Pelagia noctiluca* (Forskäl, 1771) getting more frequent in the Mediterranean basin?

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OBJECTIVES

- Present an overview on recents *Pelagia noctiluca* outbreaks and patterns in the mediterranean sea.

- Show the impact of general, regional and local climate change on the dynamics of *Pelagia noctiluca* outbreaks in term of size, timing and distribution in south western mediterranean pelagic ecosystems.

Background

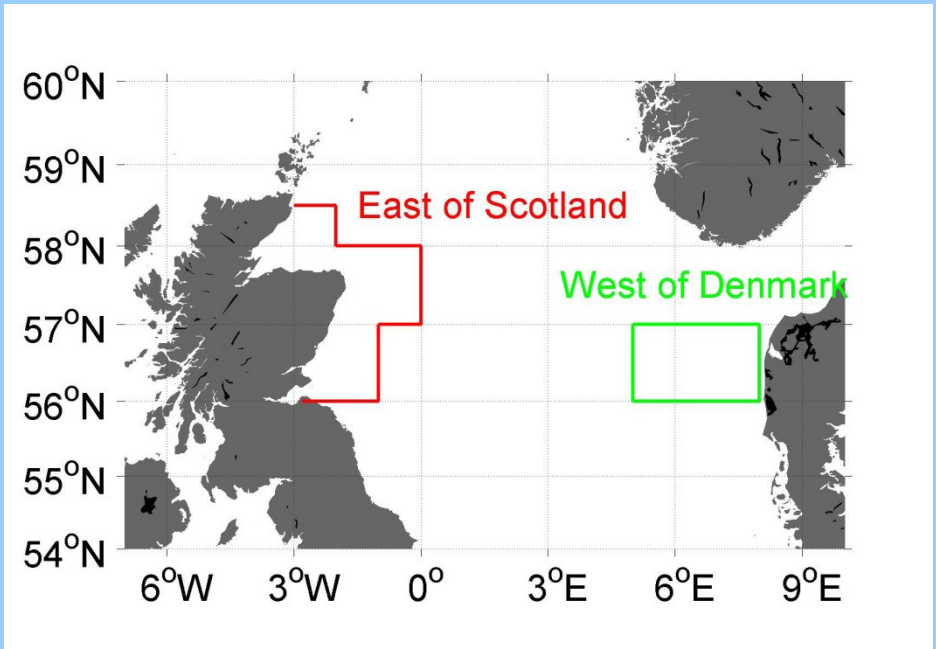
❋ Recent studies have shown that many jellyfish species known to outbreaks are favorable to warm periods while others can decrease during warming period and favored in cool period.

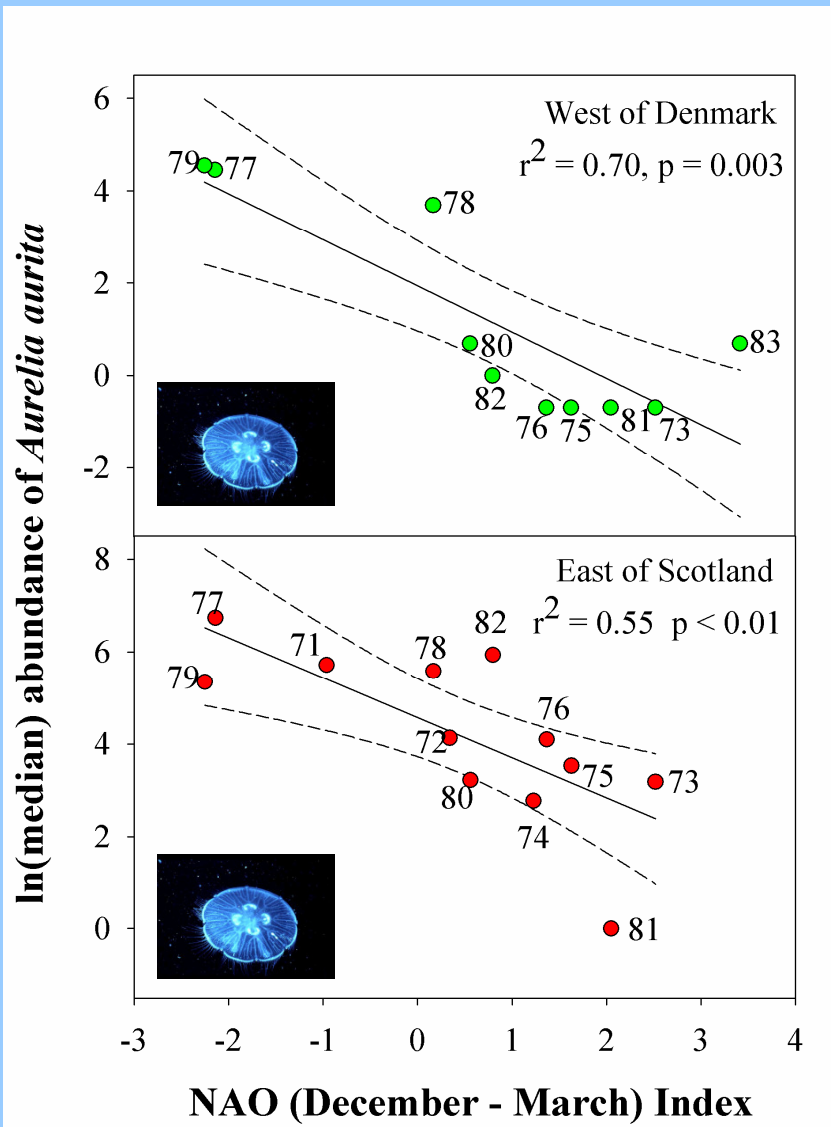
Species	Location	Warming effect on abundance	References
Aequorea victoria	**North East Pacific**	**+**	Purcell, 2005
Chrysaora quinquecirrha	**Chesapeake Bay**	**+**	Cargo & King, 1990
Liriope tetraphylla	**Mediteranean**	**+**	Buecher *et al* 1997
Pelagia noctiluca	**Mediteranean**	**+**	Goy *et al.* 1989
Abylopsis tetragona	**Mediterranean**	**+**	Buecher, 1999
Chelophyes appendiculata	**Mediterranean**	**+**	Buecher, 1999
Aurelia aurita	**North Sea**	**-**	Lynam *et al.*2004 and 2005
Cyanea capillata	**North Sea**	**-**	Lynam *et al.*2004 and 2005
Chrysaora melanaster	**Bering Sea**	**+**	Brodeur *et al.* 1999

Backgronud : Jellyfish links to the NAO

The abundance of *A.aurita* in the North Sea is negatively correlated with the winter North Atlantic Oscillation Index

(Lynam et al. *Limnol. Oceanogr.* 2004)





Background

North Atlantic climate

Regional climate

Local climate

Water temperature

jellyfish → copepods

?

Climate Downscaling method

Beaugrand et al. 2002

Beaugrand and Ibanez, 2004

Lynam *et al.* 2004

Molinero *et al.* 2005

Attrill *et al.* 2007

> *"In the western Mediterranean, climate changes during the 1980s altered plankton assemblages and food webs with high positive temperature anomalies favouring jellyfish outbreaks, which resulted in a strong decrease in the copepod abundance."*
>
> *Molinero et al. (2005)*

Data Sets

Biological data :

This work is based on the analysis of records of *Pelagia noctiluca* in different areas of the Mediterranean basin from 1978 until 2007:

- North Tunisian Pelagic Ecosystems : **quantitative data from 1993 - 2007**
- Baleares : **semi-quantitative data from 1994 - 2007**
- Aegean Sea : **semi-quantitative data from 1983 - 2007**
- North and South Adriatic Sea : **semi-quantitative data from 1978 - 2007**

Climate data:

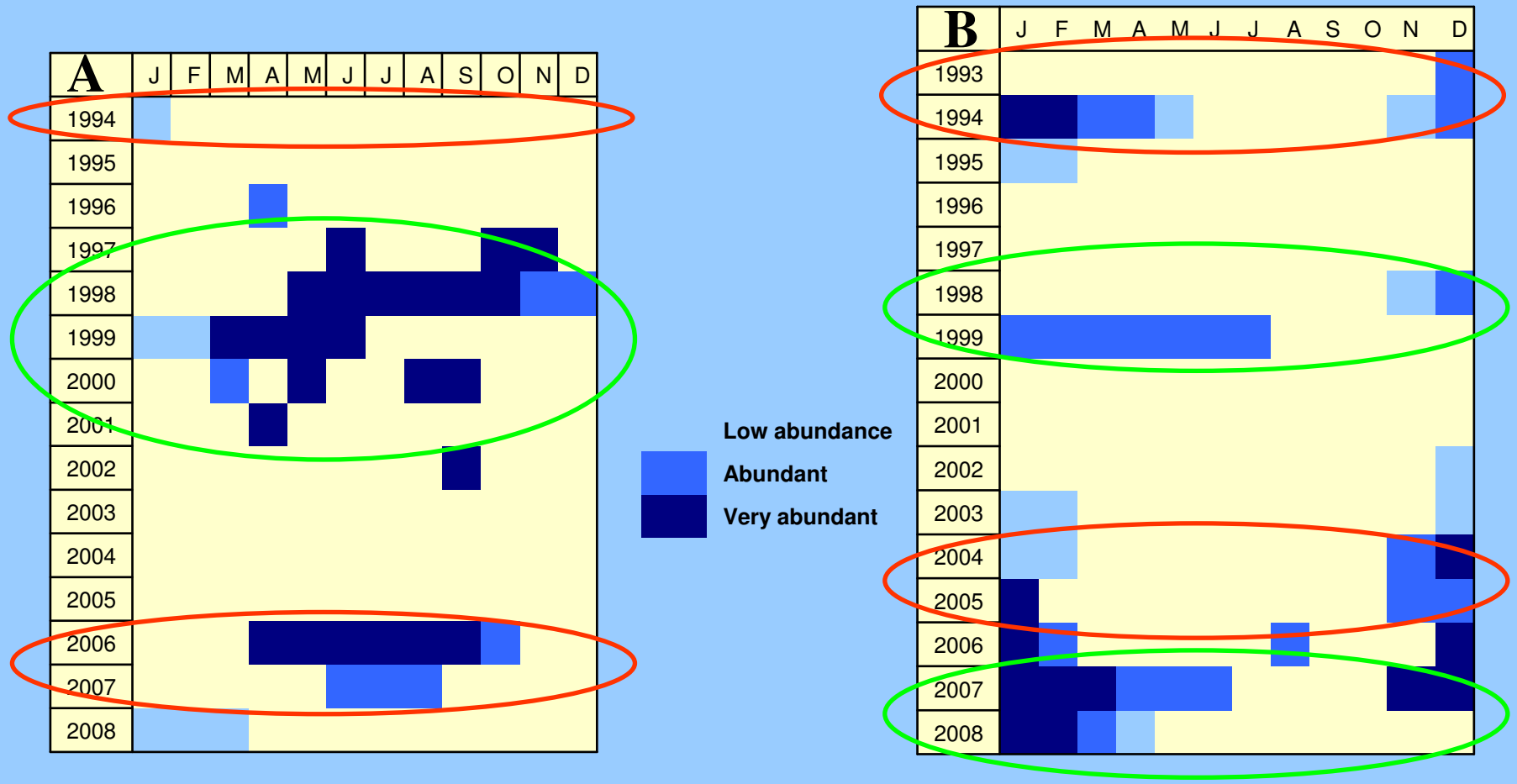
- Available large-scale climate patterns : **NAO and NHT** will be used.
- A **Regional Atmospheric Index** will be used for each region.

Large-scale climate patterns correspond to key-modes of low frequency atmospheric oscillation governing the Northern Hemisphere weather.

Hydrological data :

- Standard records of temperature and salinity.
- Sea Surface Temperature of the Mediterranean Sea

Pelagia noctiluca recent outbreaks and Patterns in the study area



Variability of the seasonal peak of *Pelagia noctiluca* over the period ranging from 1994 – 2008 (A : Baleares) and from 1993 – 2008 (B : Gulf of Tunis).

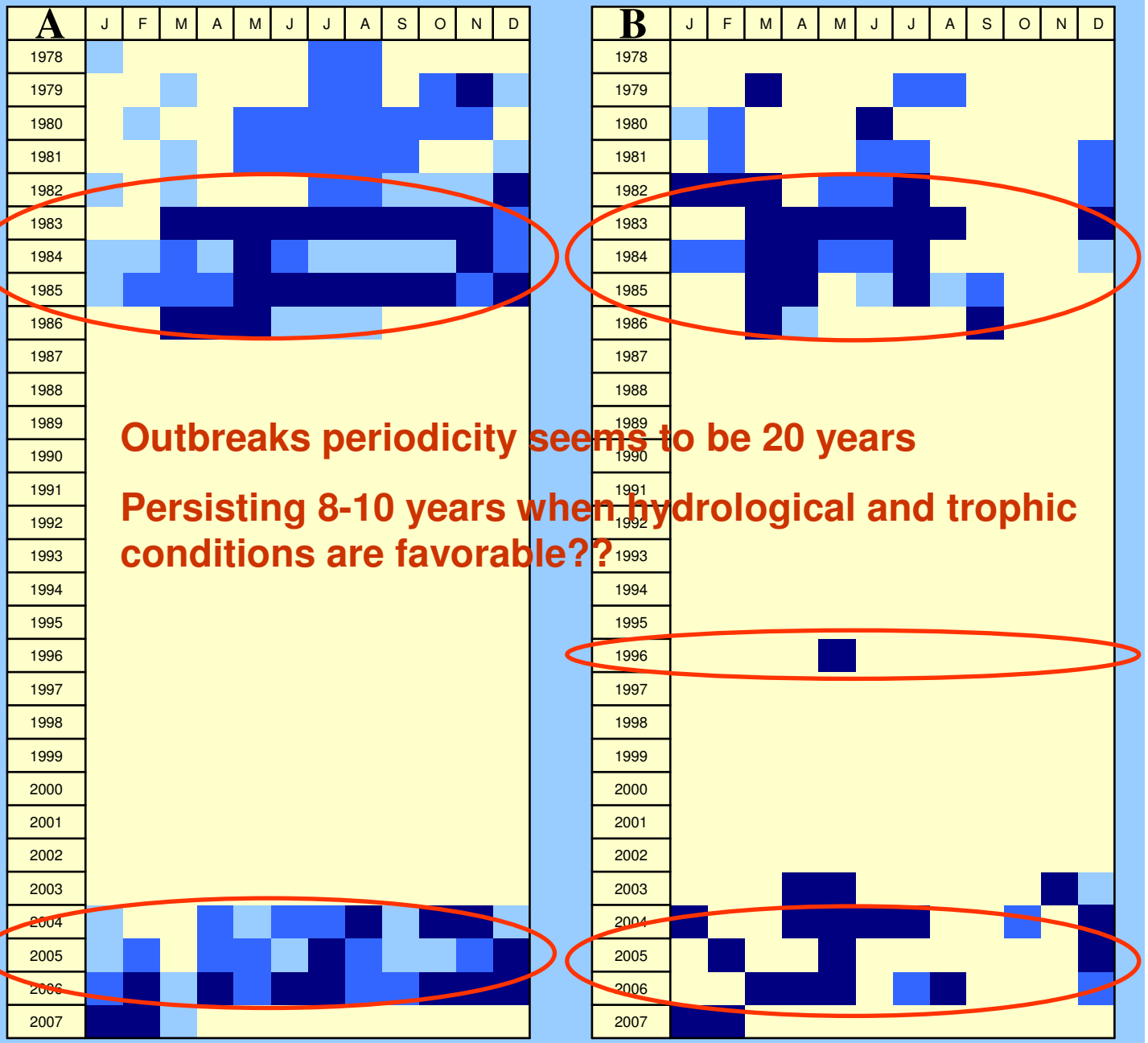
« Normal » or Predictible events according to Goy et al. 1989, decadal model

« Non Regular » or Unpredictible events

Pelagia noctiluca recent outbreaks and Patterns in the study area

Variability of the seasonal peak of *Pelagia noctiluca* over the period ranging from 1978 – 2007.
A : North Adriatic Sea ;
B : South Adriatic Sea.

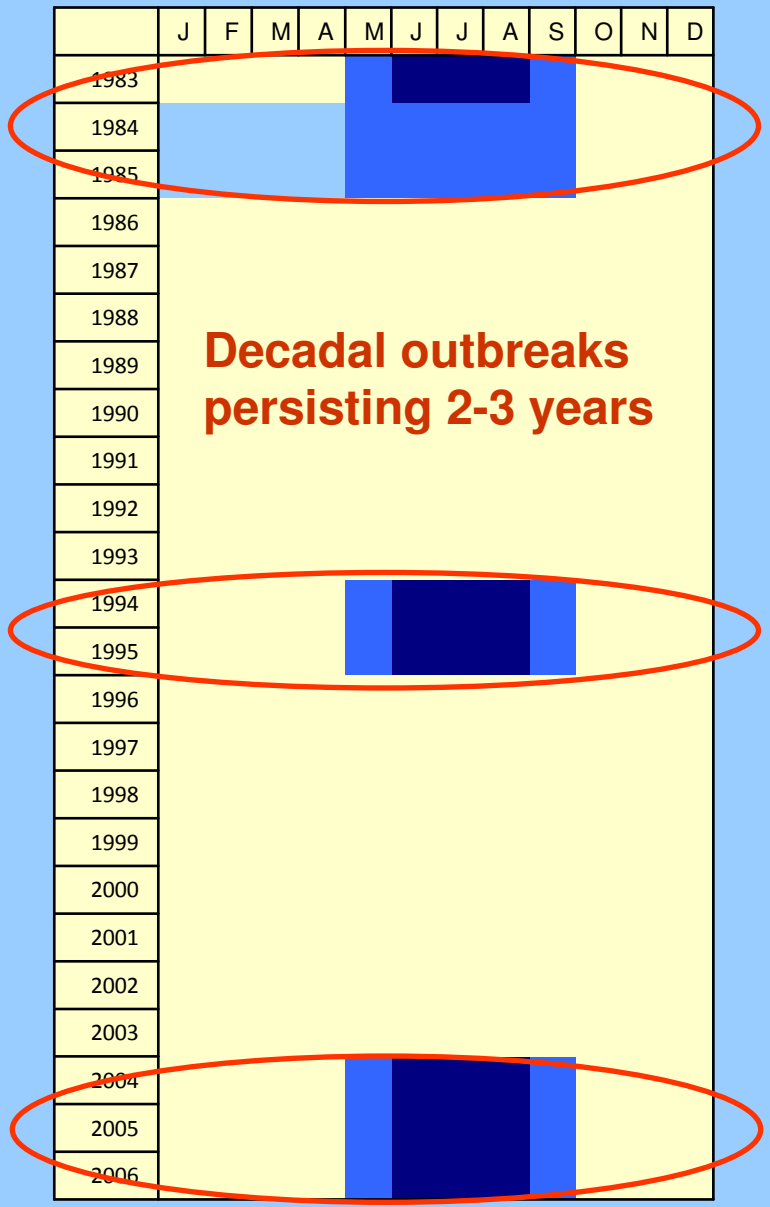
(Data are compiled from several publications and local reports)



Outbreaks periodicity seems to be 20 years

Persisting 8-10 years when hydrological and trophic conditions are favorable??

Pelagia noctiluca recent outbreaks and Patterns in the study area



Variability of the seasonal peak of *Pelagia noctiluca* over the period ranging from 1983 – 2006 in the Aegean Sea. (Data are compiled from local reports)

QUESTIONS ??

1- Does the regional modifications of *Pelagia noctiluca* abundance and timing are triggered by largescale and/or local hydroclimatic processes?

2- What's the best climatic or hydroclimatic index should we use to predict timing and intensity of *Pelagia noctiluca* outbreaks?

NAO, an index controlling Europe and Mediterranean climate

The North Atlantic Oscillation is a variation of the relative strengths and positions of the Iceland Low pressure (L) and the Azores High pressure (H), controlling the direction and strength of westerly winds into Europe and Mediterranean Sea.

❑ **A low index year (NAO-)** means that Azores High (H) is lower than the normal winter value while Iceland Low (L) is weakly deeper.

➢ **Suppress westerly winds.**

➢ Decrease in storm and rainfall frequency and intensity in North and Central Europe.

➢ **Induce a wet climate with mild winters in the Mediterranean Sea and North Africa and increase storms and rainfalls activities.**

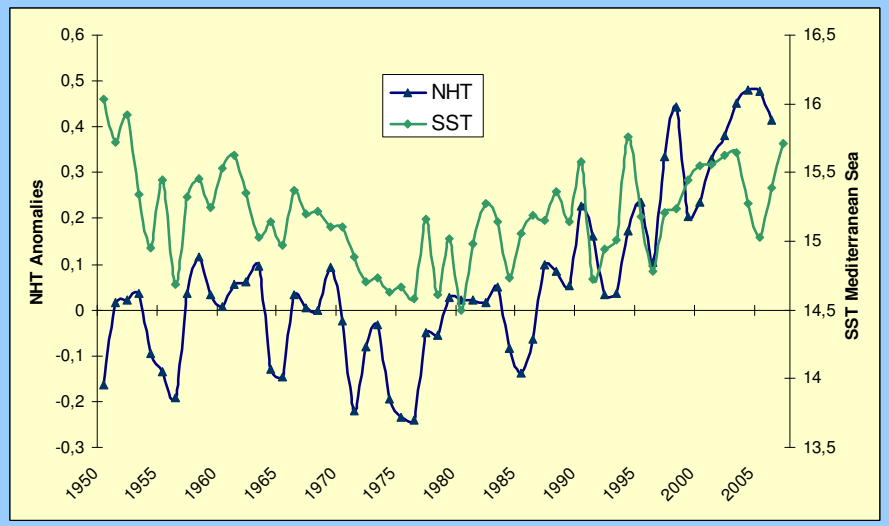
❑ **A high index year (NAO+)** means that Azores High (H) is higher than the normal, while Iceland Low (L) is deeper.

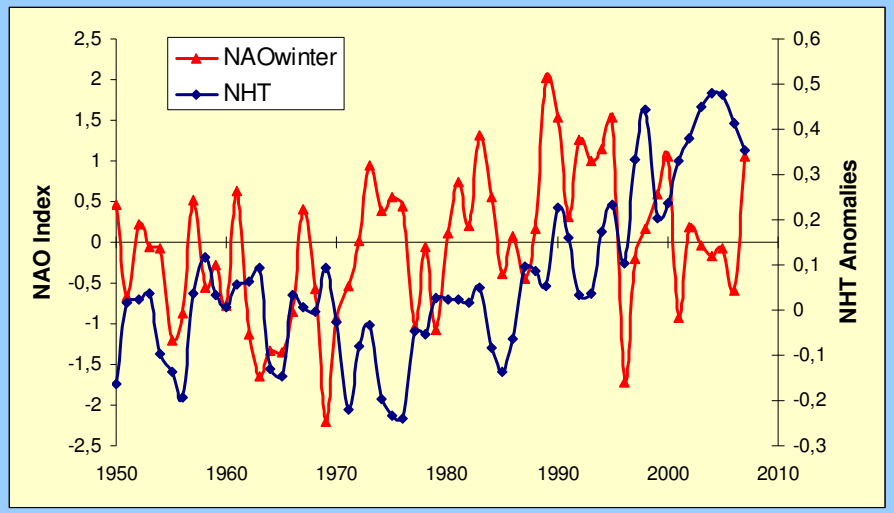
➢ **Increase westerly winds.**

➢ Increase storm and rainfall frequency and intensity in North and Central Europe with mild and wet winters and cool summers.

➢ **Induce dry climate with cold winters in the Mediterranean Sea and North Africa**

North Hemispheric Temperature anomalies : a climate index influenced by NAO





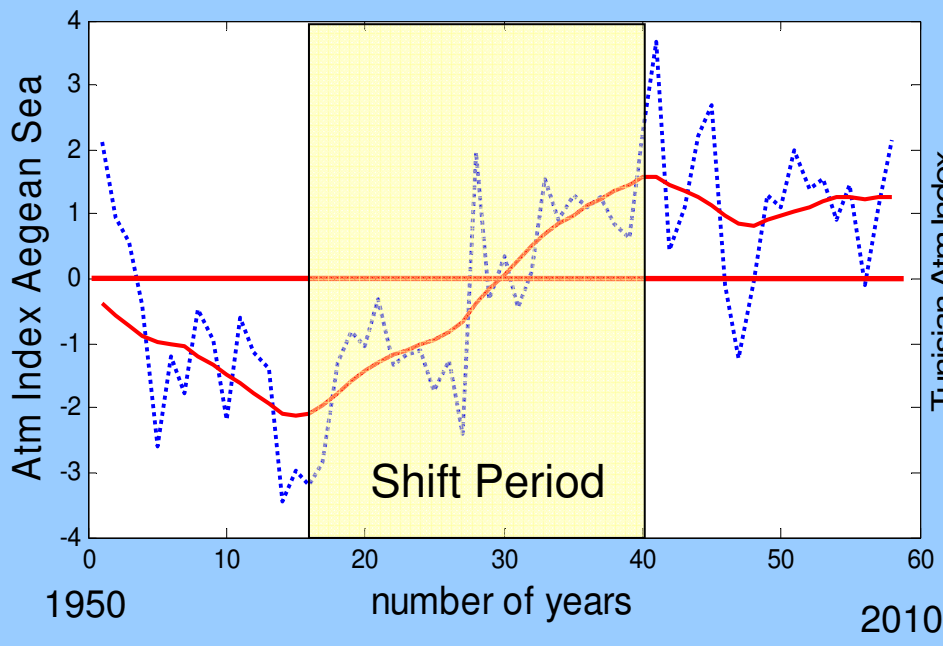
There's a change in the relationship between NAO – NHT due to solar activity (Gimeno *et al*. 2003)

NHT and Sea Surface Temperature in the Mediterranean are correlated

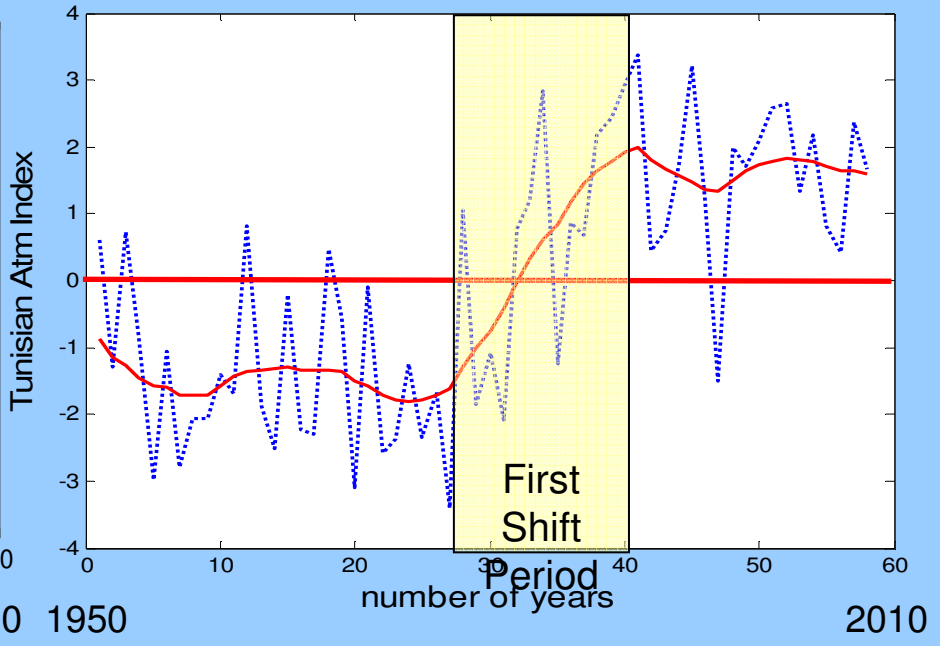
NHT influence also regional atmospheric Climate

Dr Juan Carlos Molinero from IFM-GEOMAR (Kiel, Germany) performed a **Regional Atmospheric Index (RAI)** based on Sea Level Pressure, Air Temperature, Sea Surface Temperature, Precipitations, Geopotential Heigh and Wind Stress

North Adriatic Sea RAI

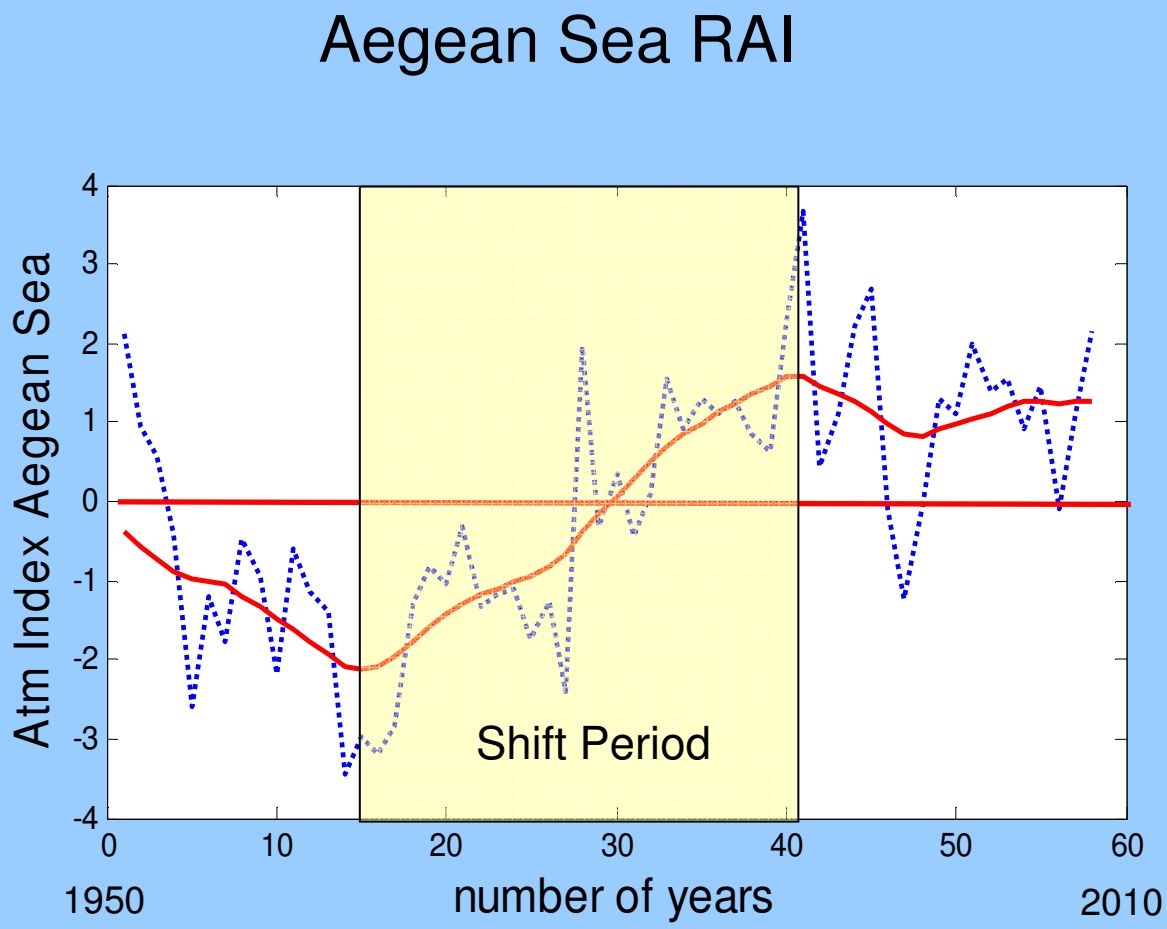


Gulf of Tunis RAI



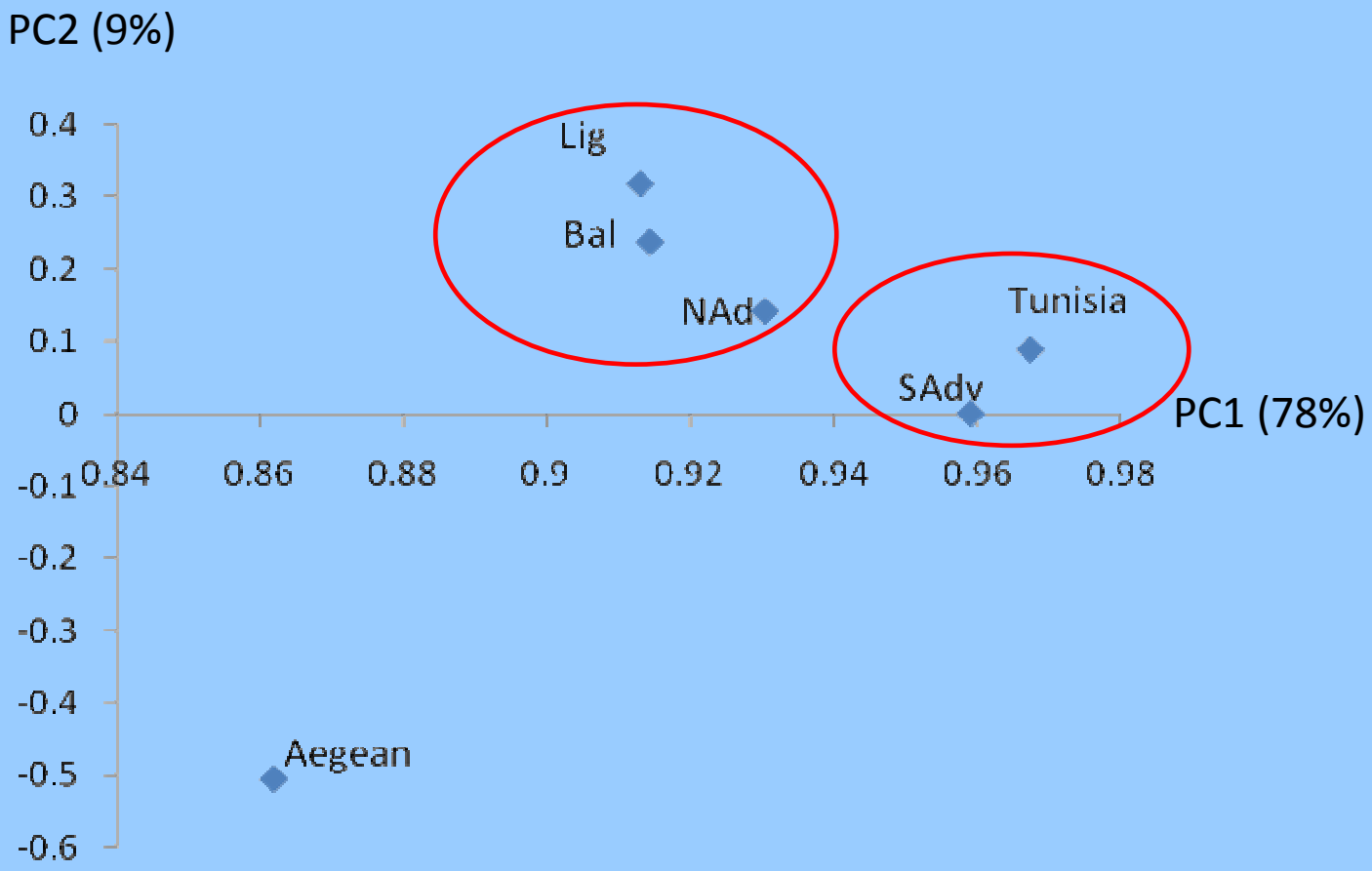
North Adriatic Sea and Gulf of Tunis Regional Atmospheric Index calculated for the period 1950 - 2008

NHT influence also regional atmospheric Climate



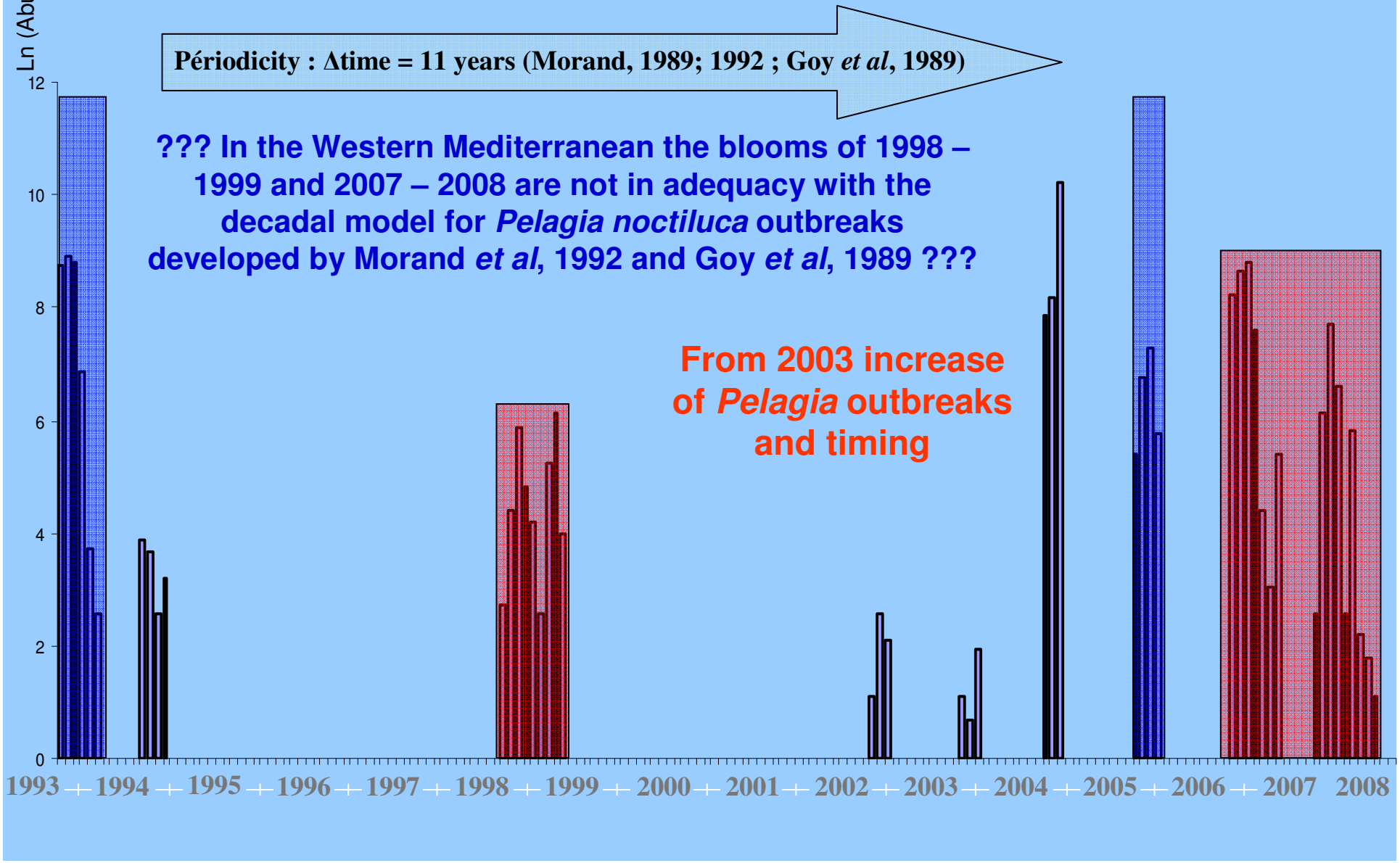
Aegean Sea Regional Atmospheric Index calculated for the period 1950 - 2008

Statistical analysis to characterize regional climate similarities

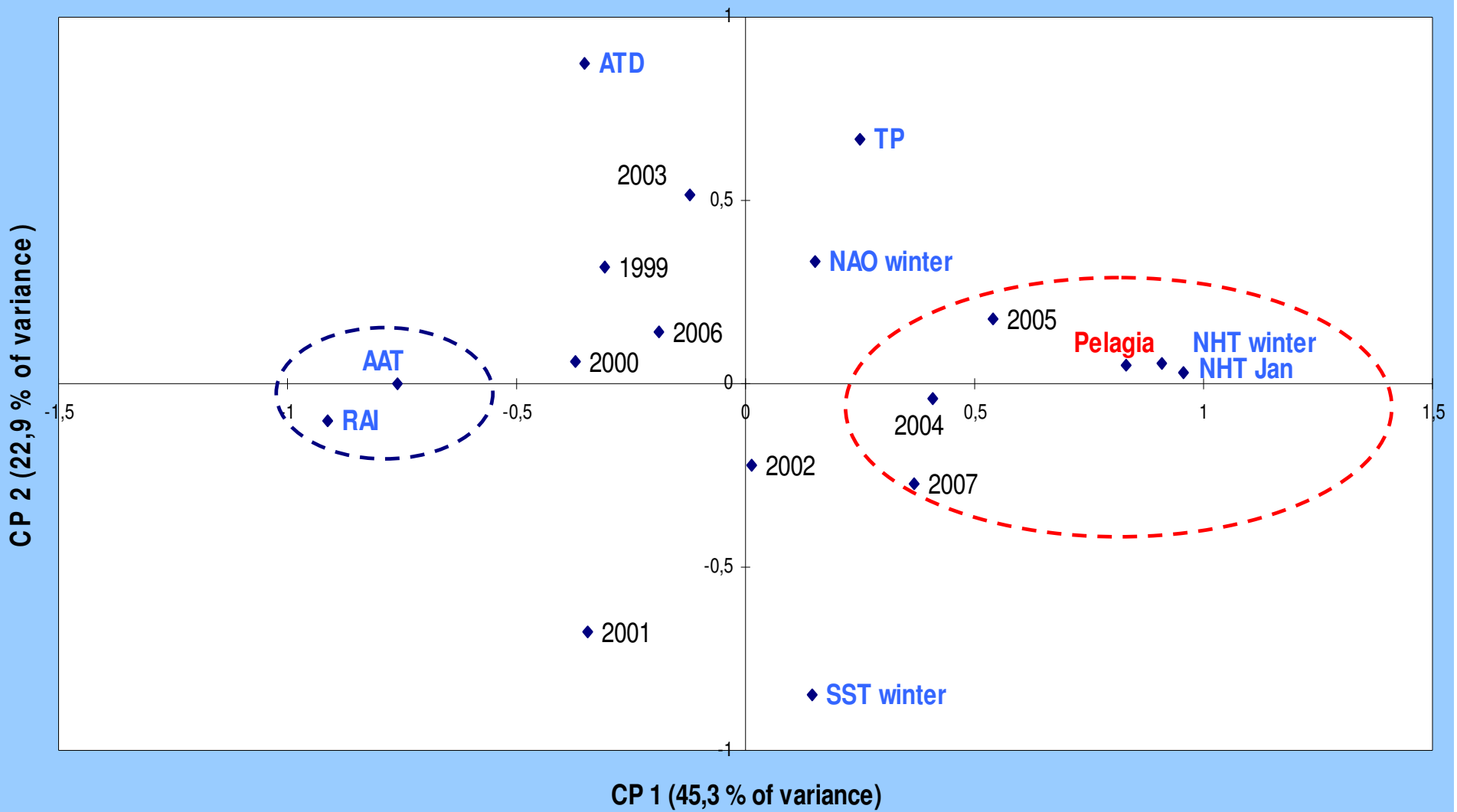


PCA of the different study areas according to their local climate atmospheric indexes

Pelagia noctiluca dynamics of outbreaks in Tunis Gulf between 1993 and 2008



Statistical analysis



Principal Components Analysis between Climate and Hydroclimate variables and Abundance of Pelagia noctiluca in the Gulf of Tunis for the period 1999 – 2007.

AAT : Average Annual Temperature ; **ATD :** Annual Temperature Deviation ; **NAO winter :** North Atlantic Oscillation index from Dec to March ; **NHT winter :** North Hemisphere Temperature index from Dec to March ; **NHT Jan :** NHT January ; **Pelagia :** Pelagia average abundance ; **RAI :** Regional Atmospheric Index for North Tunisia ; **SST winter :** Sea Surface Temperature in winter months ; **TP :** Total Precipitations.

Conclusions

- *Pelagia noctiluca* outbreaks intensity and timing are changing in the western mediterranean basin in relation with climate variability.
- The best climatic indexes controlling *Pelagia noctiluca* outbreaks seems to be the NHT winter, RAIndex and local AAT. The NAO index seems to play a role at a higher level not easy to demonstrate statistically.
- *Pelagia noctiluca* can be considered as a fingerprint or indicator of climate variability
- It seems that *Pelagia noctiluca* should also be considered as an indicator of trophic changes in the marine food web. (to be confirmed)

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"Impact of Global Changes on the Dynamic of Carnivorous Gelatinous Plankton in Mediterranean Pelagic Ecosystems"

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