

*Effects of the Adriatic-Ionian **Bi**modal **O**scillating **S**ystem (**BIOS**)
on the biogeochemistry and biology of the Ionian and Adriatic Seas*

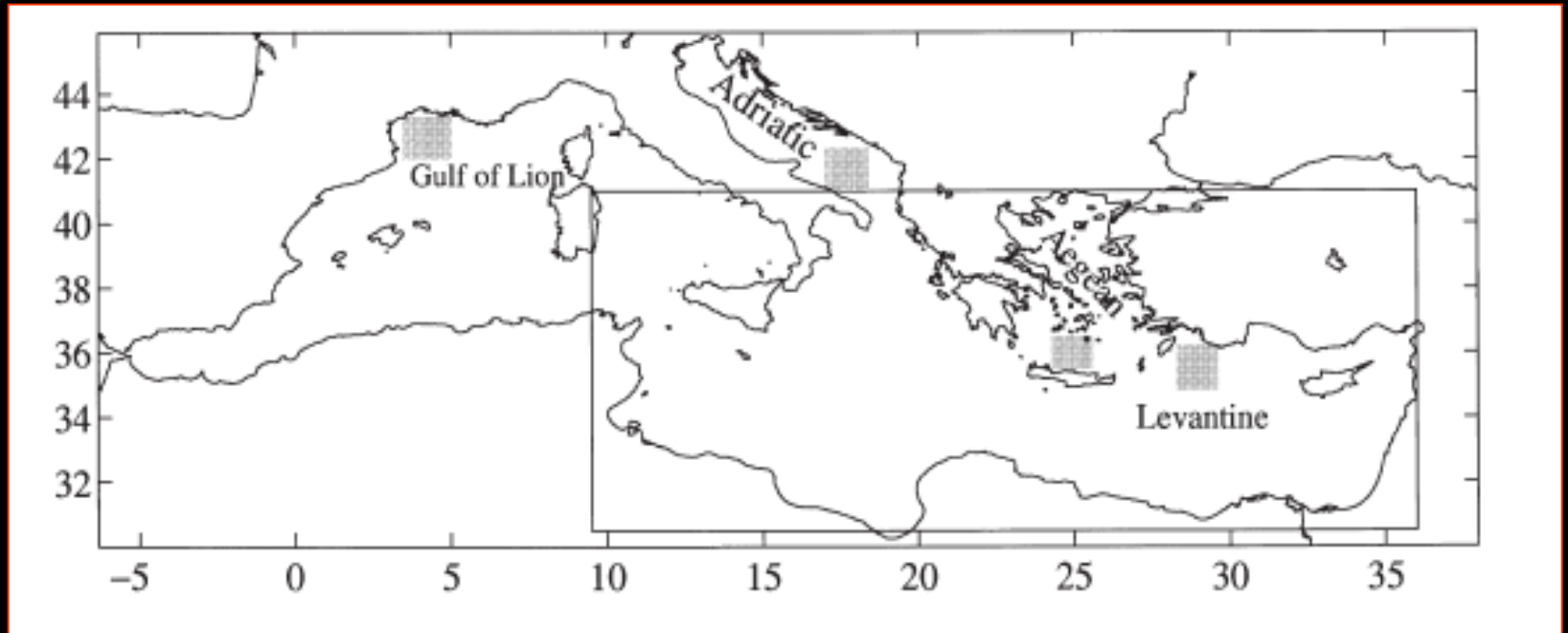
M. Gačić, Civitarese G. and G. L. E. Borzelli



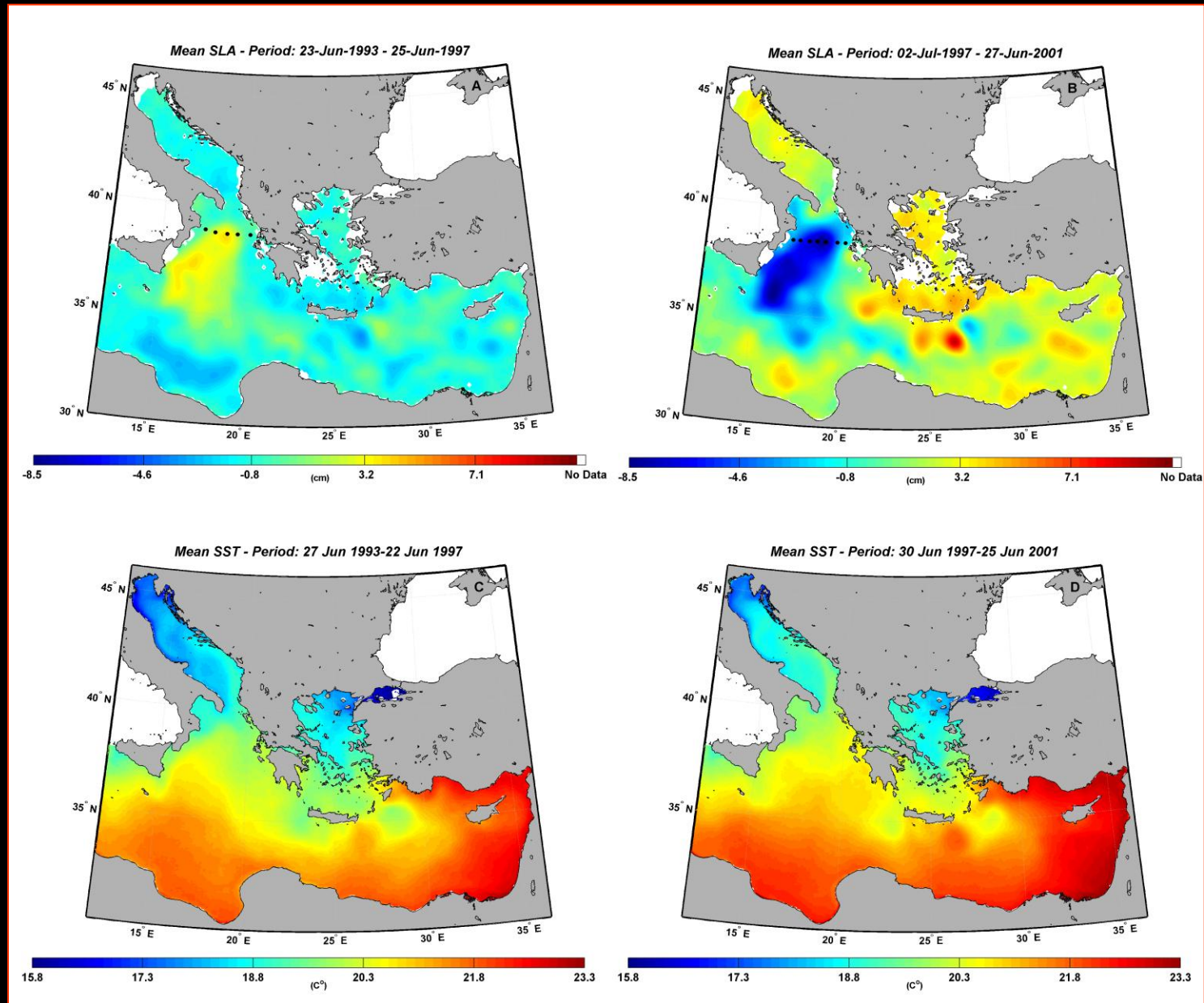
Mali Losinj, August 2010



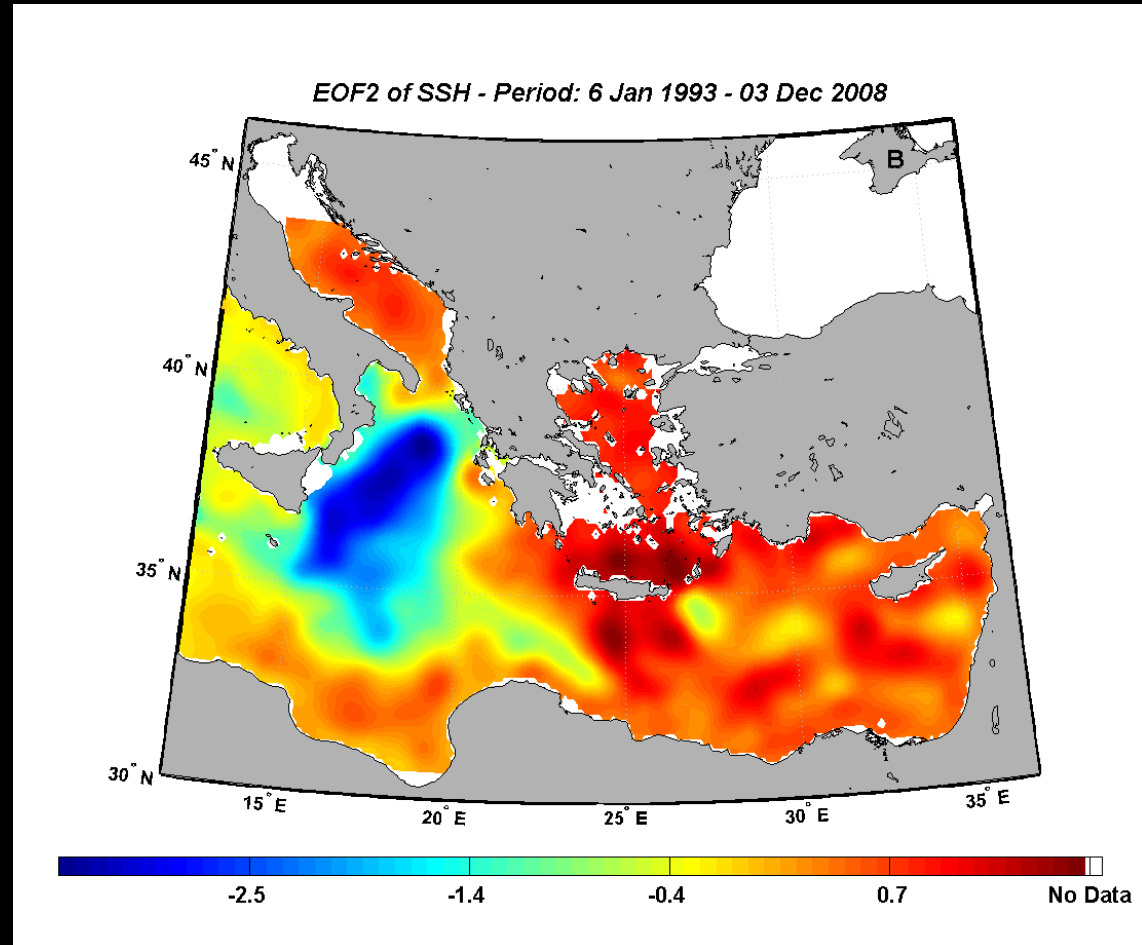
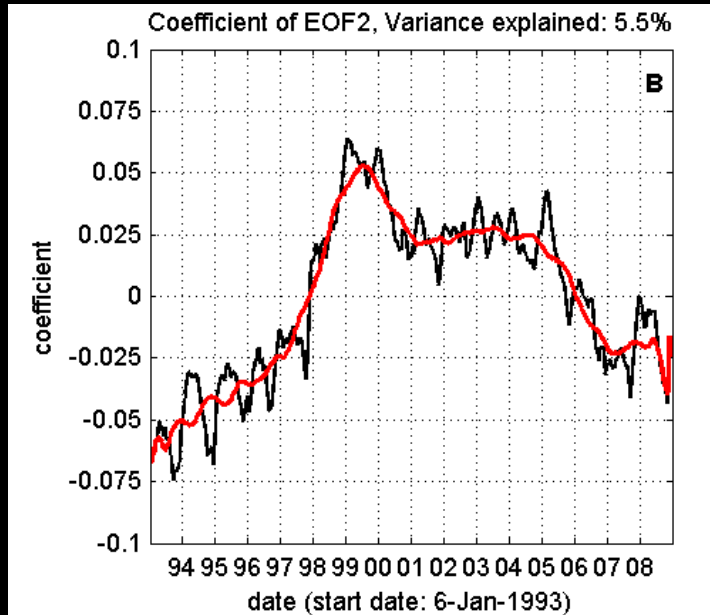
Mediterranean Sea. Shaded areas mark the sites of dense (intermediate and deep) water formation.



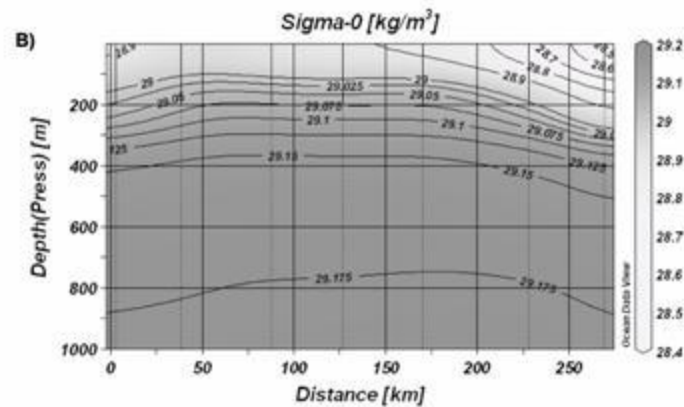
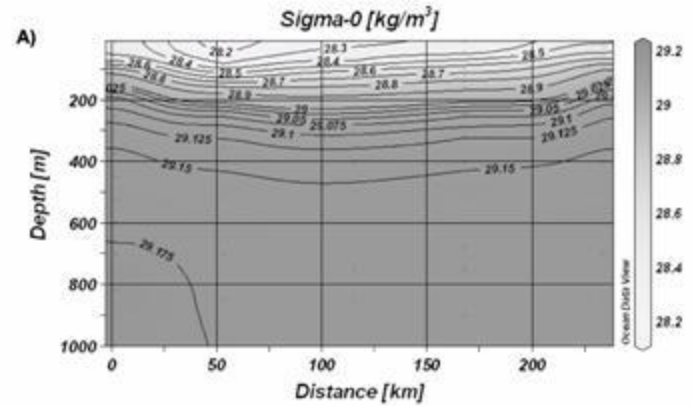
Oceanographic features of the Eastern Mediterranean in the last two decades



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The Adriatic-Ionian **BiOS**

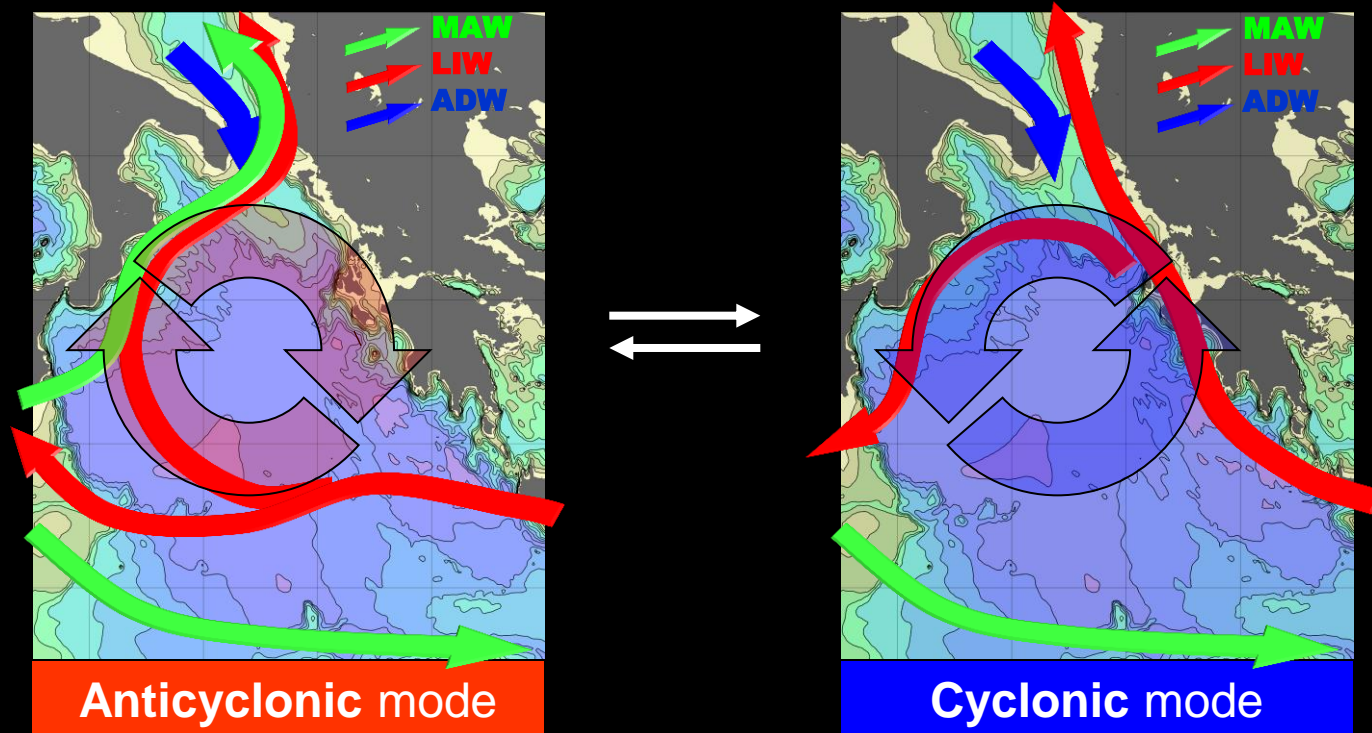
BiOS stands for **Bi**modal **O**scillating **S**ystem.

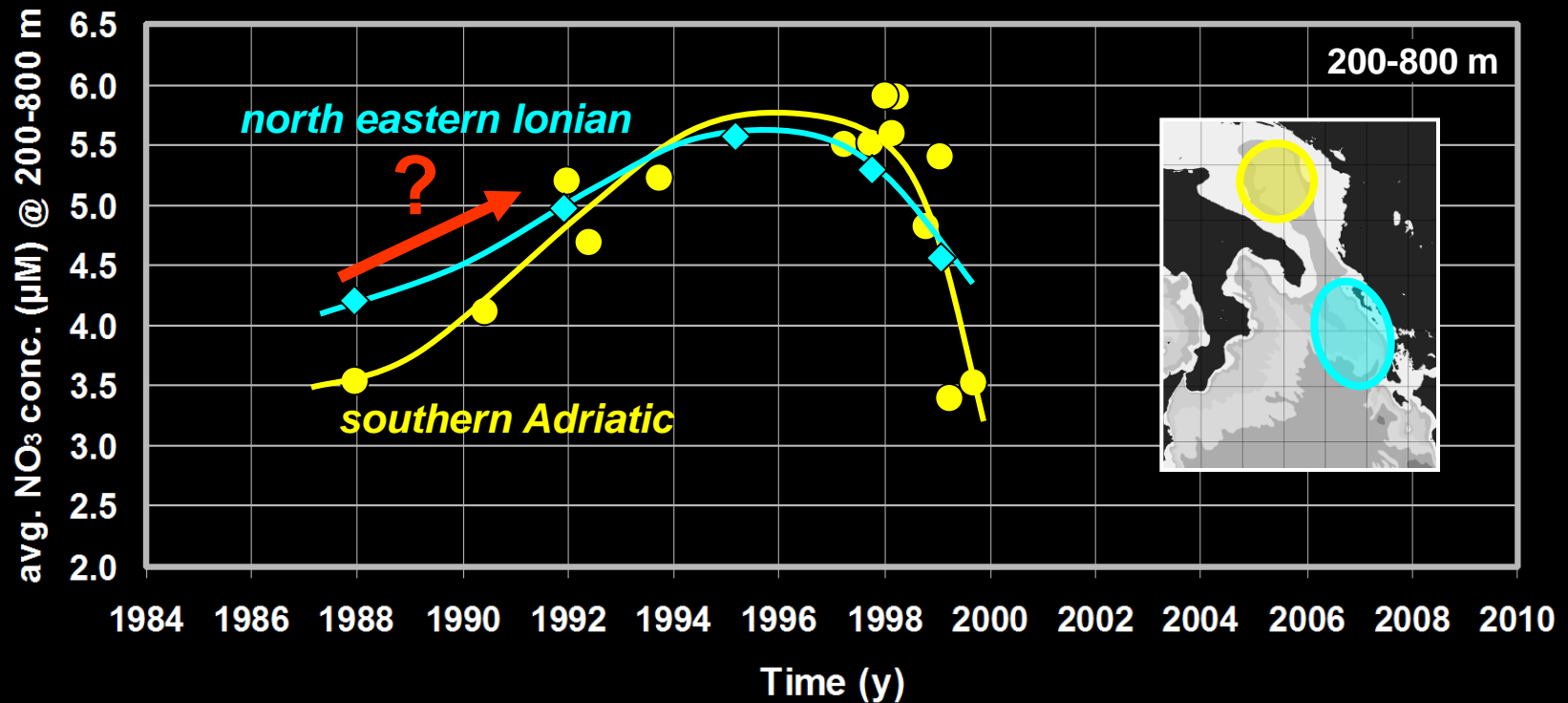
It is the **negative feedback mechanism** between variations in thermohaline properties of the water mass formed in the Southern Adriatic and the upper-layer circulation in the Ionian Sea.

Gačić M., G. L. Eusebi Borzelli, G. Civitarese, V. Cardin, S. Yari.

Can internal processes sustain reversals of the ocean upper circulation? The Ionian Sea example.

Geophys. Res. Letters, 2010.

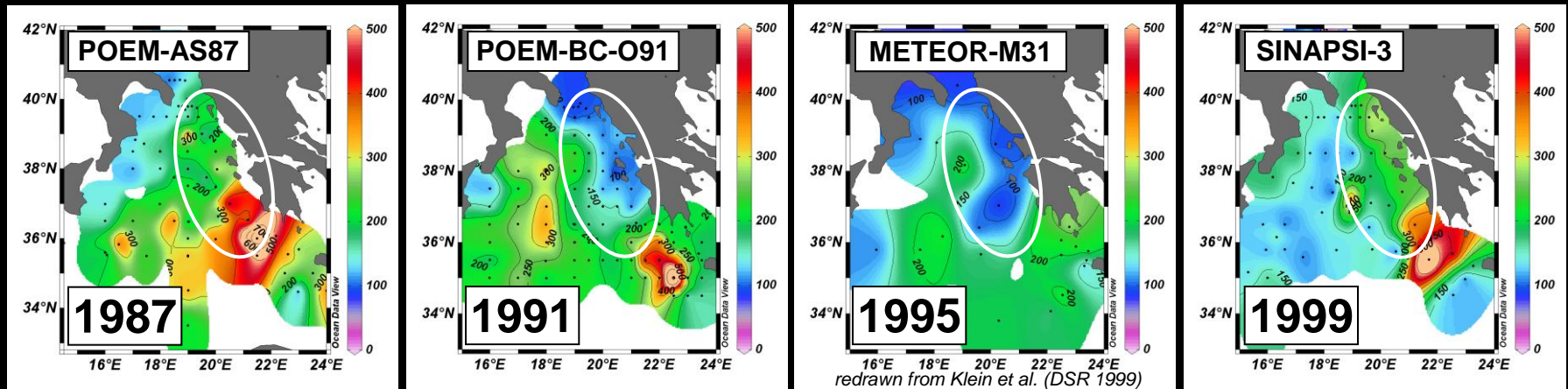




The interannual variability of the nutrient levels in the Southern Adriatic was ascribed to the **uplifting** (due to the EMT) of nutrients advected from the Ionian Sea. [Civitarese and Gacic, GRL 2001]

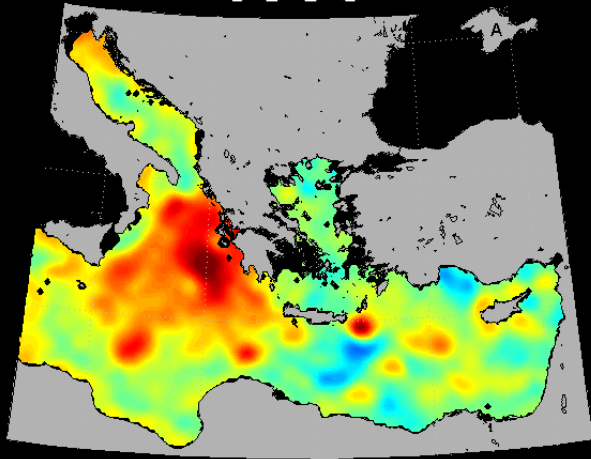
The fact that the nutrient increase apparently started since 1988 (when the EMT was not yet present) **remained unexplained...**

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Distributions of the nitracline depths (defined as the depth where $[NO_3] = 3 \mu M$)

1993



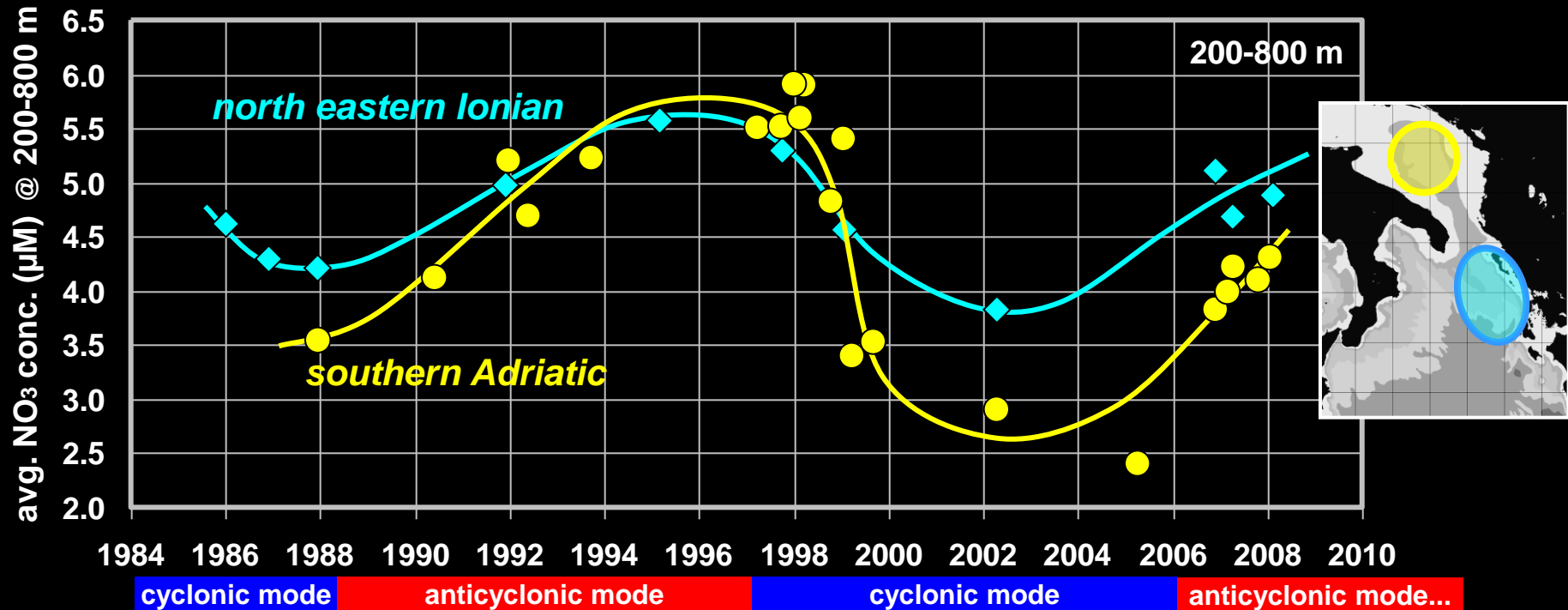
Sea Level Anomaly

(autumn average from 1993 to 2007)

From late 1980's to now, the upper circulation regime in the Ionian **reversed** three times:

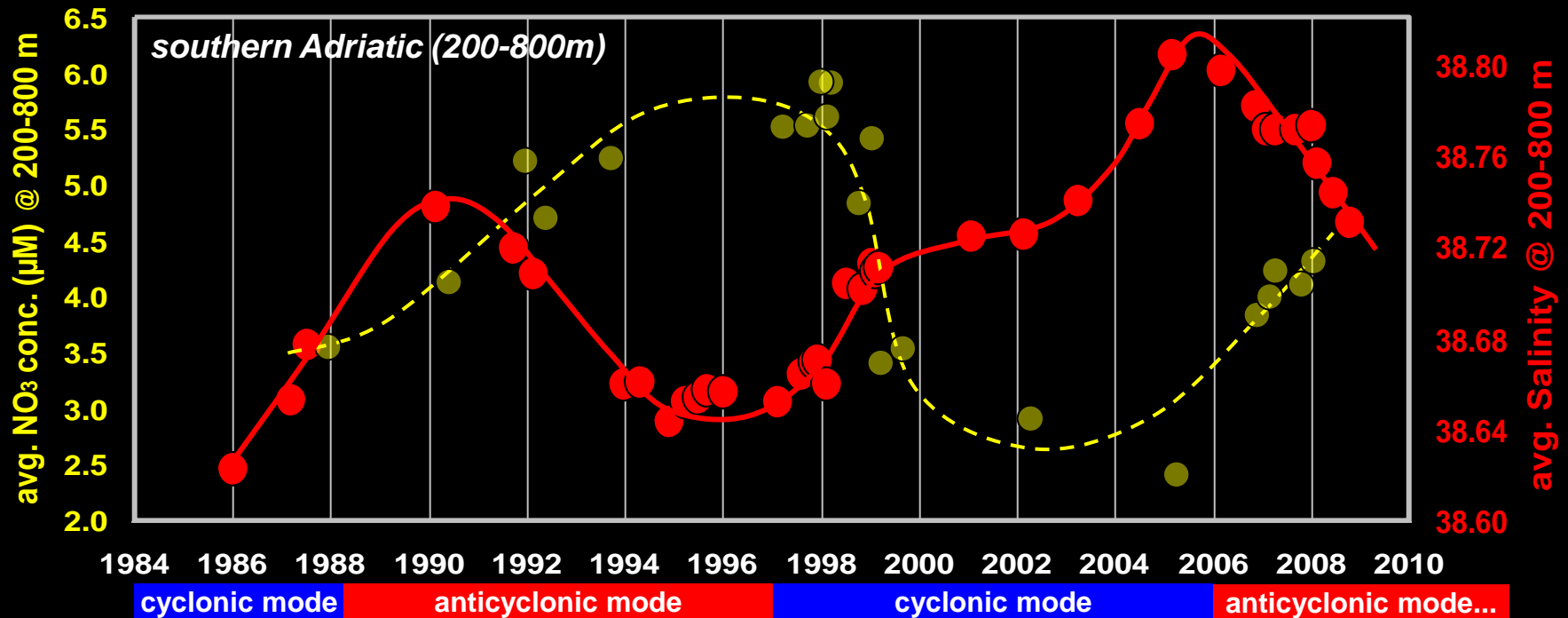
- **late 1980's**: cyclonic \rightarrow anticyclonic;
- **1997-98**: anticyclonic \rightarrow cyclonic;
- **2008**: cyclonic \rightarrow anticyclonic.

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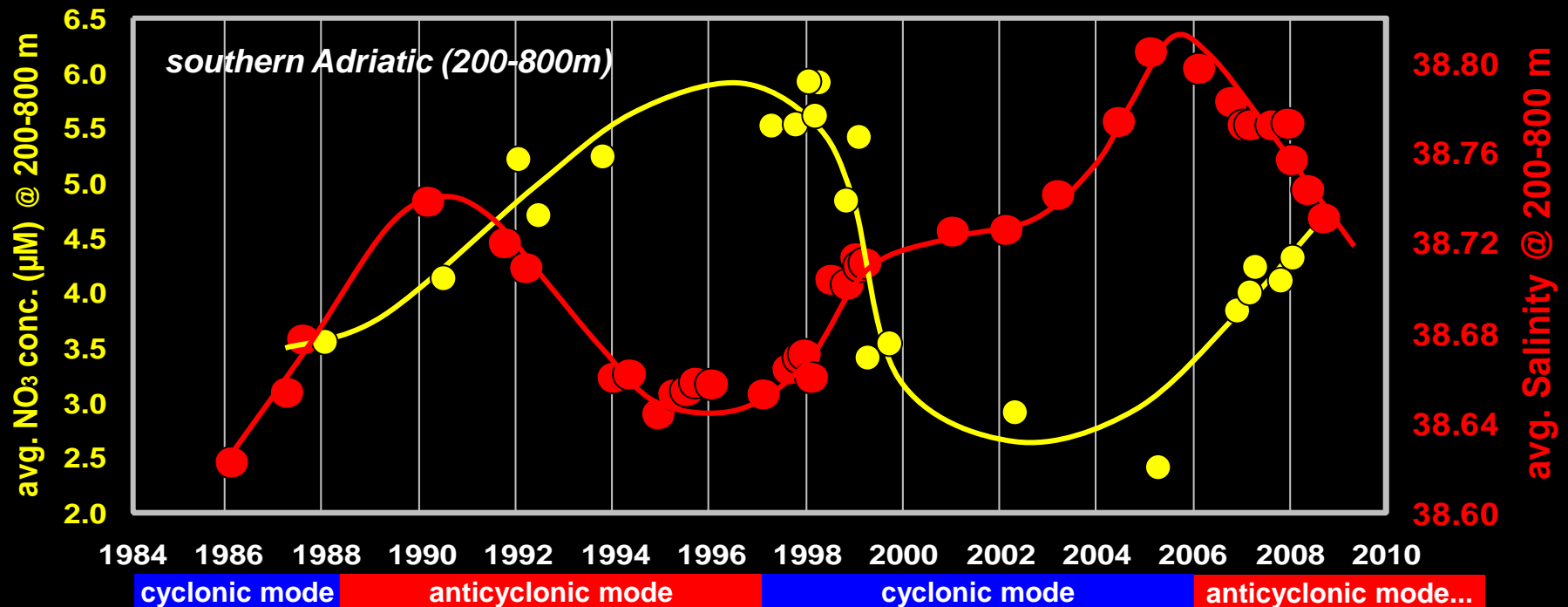
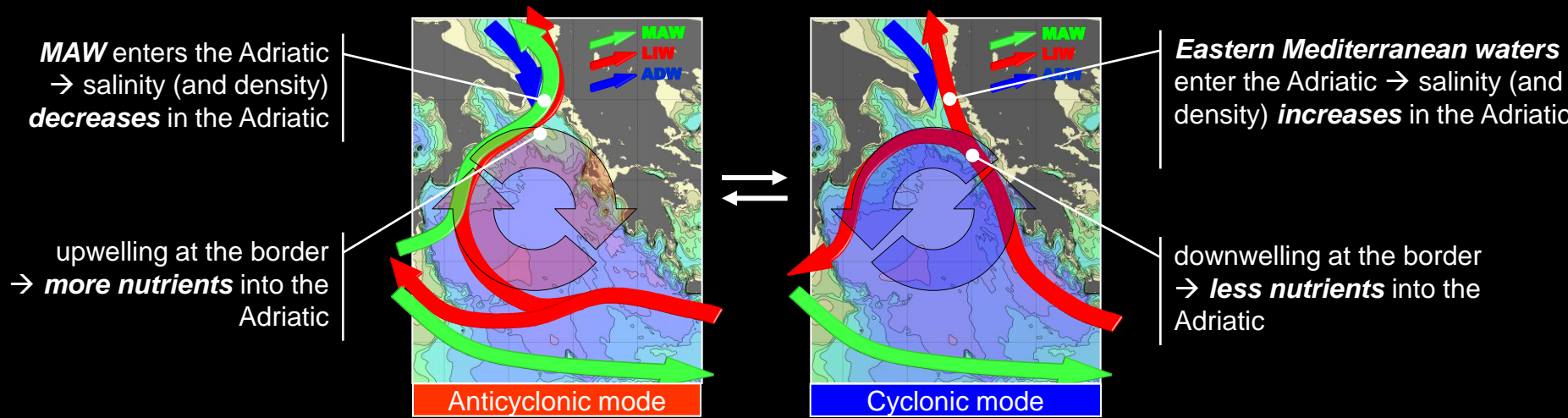
The ***change in the vertical displacement*** of the oceanographic interfaces (as the nitra/nutricline) in the Ionian Sea, determined a ***change of the amount of nutrients*** imported into the Adriatic.

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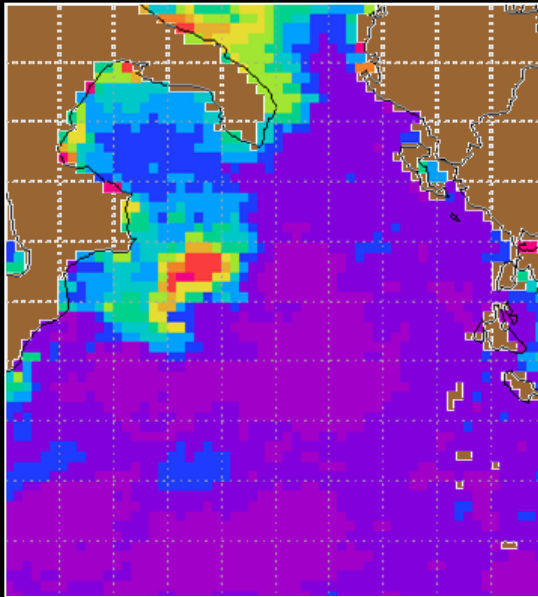
The **thermohaline properties** of the Southern Adriatic show a similar interannual variability, **out of phase** with respect to nutrients. In this case, the variability seems to be associated to **different water masses** entering the Adriatic, following the upper-layer circulation regime in the Ionian Sea.

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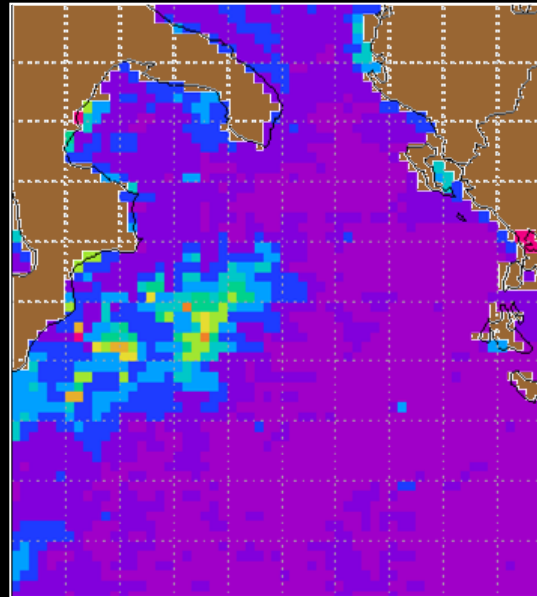


Impact

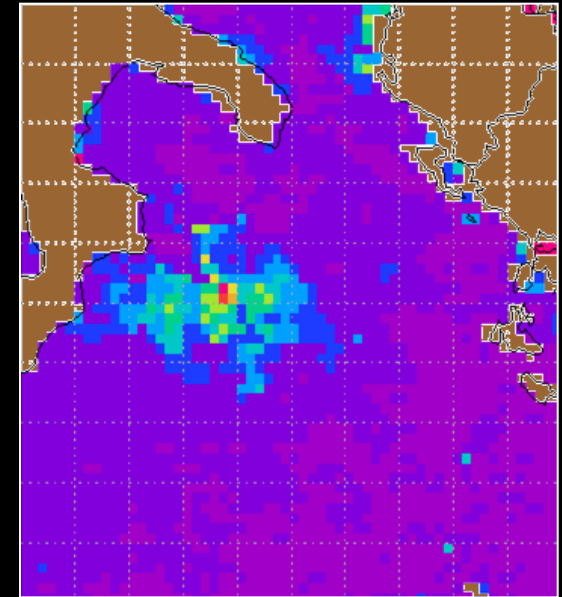
SeaWiFS Chlorophyll *a*
March, 1998



SeaWiFS Chlorophyll *a*
March, 1999



SeaWiFS Chlorophyll *a*
March, 2000



The EMT, *per se*, **did not affect** the general patterns of biomass distribution in the Eastern Mediterranean. On the other hand, **only in the Ionian Sea**, after the reversal of the upper circulation (anticyclonic → cyclonic), a recurrent and large bloom was detectable [D'Ortenzio et al., *JGR* 2003].

Impact



1987: the reversal in the Ionian sea circulation influenced the *copepod* northerly extension and abundance in the Gulf of Trieste [Conversi et al., *JGR* 2009].

1995: *Muggiaea atlantica* was recorded for the first time in the southeastern [Gamulin and Kršinić, *NC* 2000] and central Adriatic [Batistić, *JMBA* 2003].

1997: *Muggiaea atlantica* invaded the northern Adriatic [Kršinić and Njire, *AA* 2001].

1993-1996: increased population of *Pelagobia longicirrata* [Batistić, *JPR* 2004].

1996: the pteropod *Desmopterus papilio* was found off Dubrovnik [Batistić, *JPR* 2004].

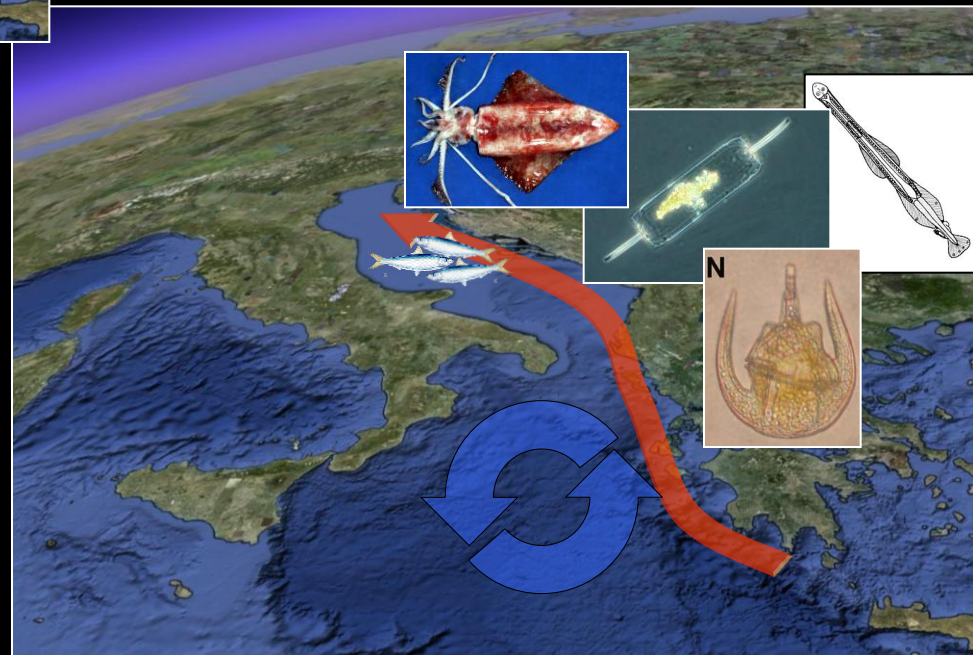
1997: changes in some *copepod* species in the Gulf of Trieste [Conversi et al., *JGR* 2009].

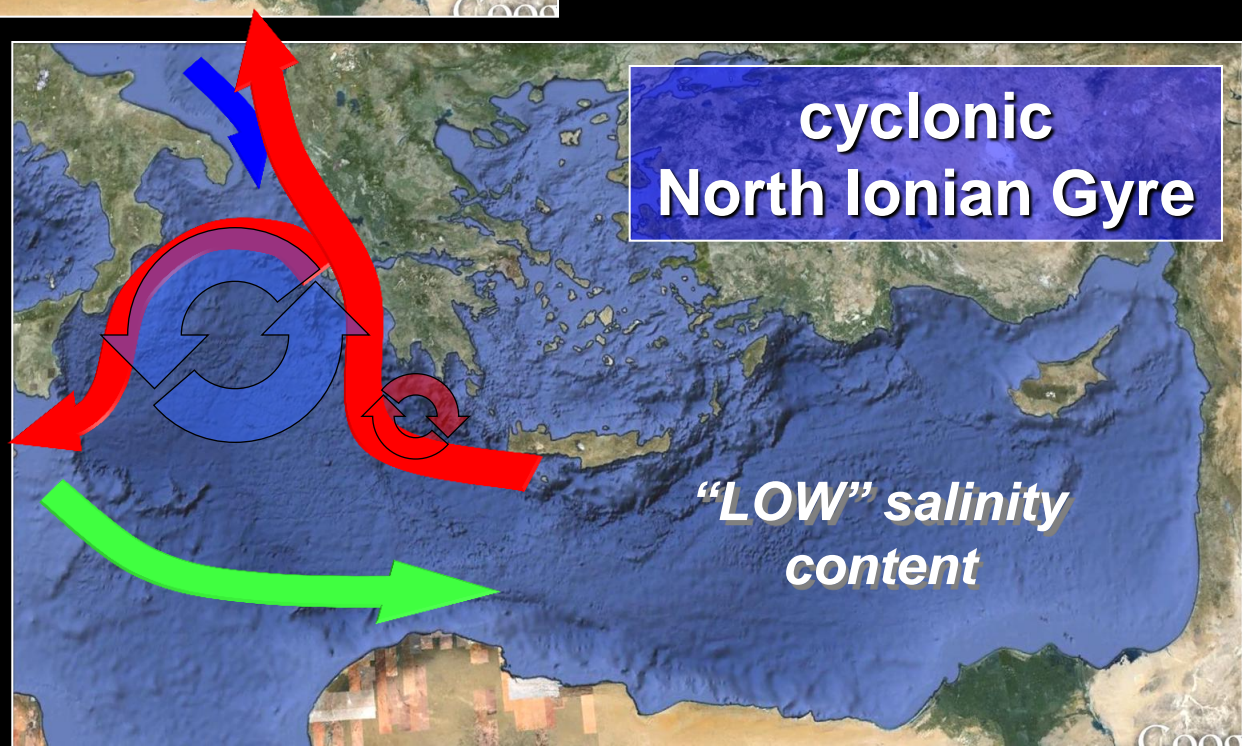
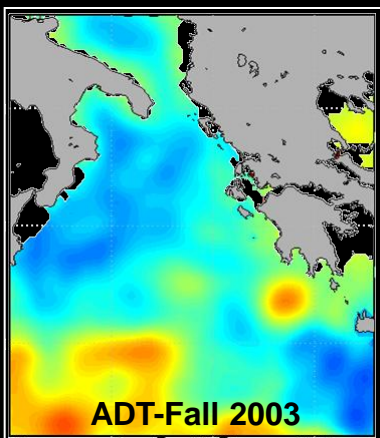
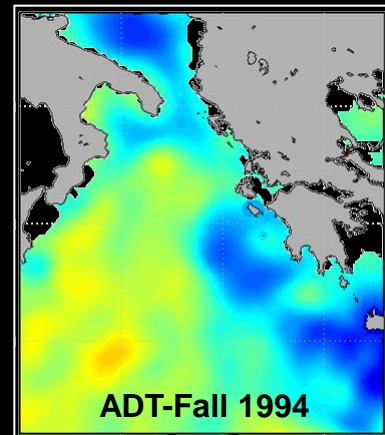
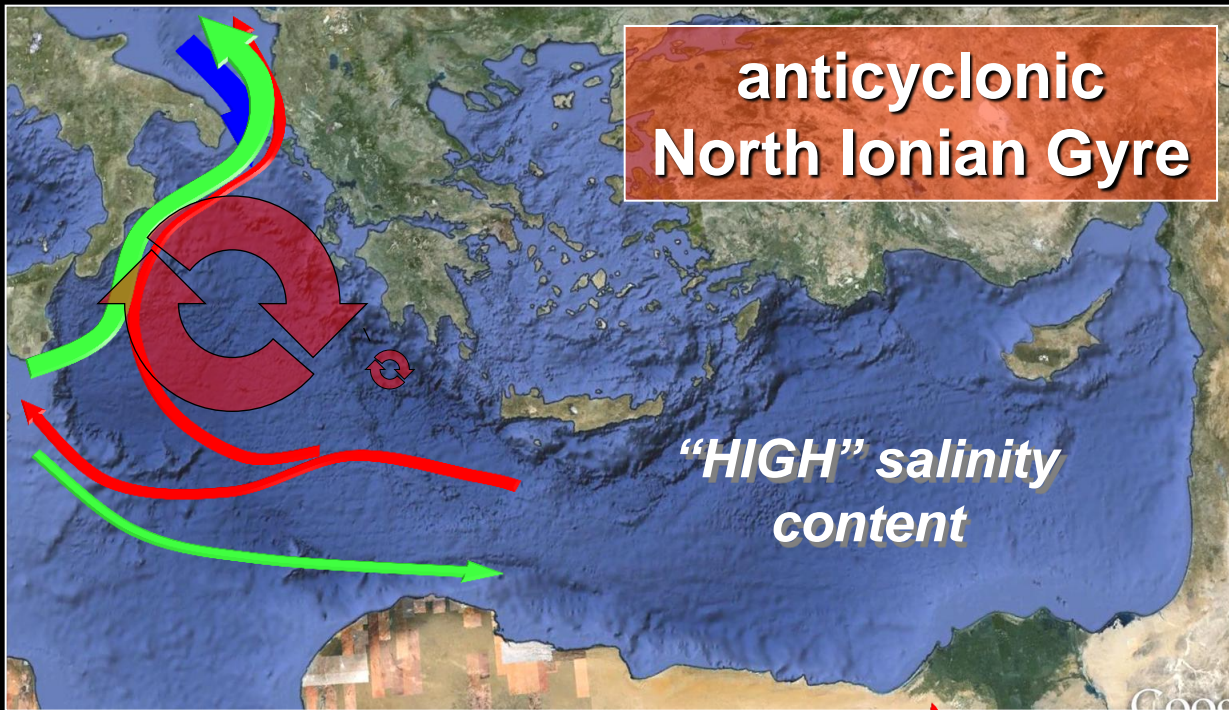
from 2001: *new species* entered the Adriatic from the Eastern Mediterranean [Batistić, *pers. comm.*].

2006: *Thysanoteuthis rhombus* was introduced by the currents during entrance of Ionian waters [Marčić et al., *JMBA2* 2008].

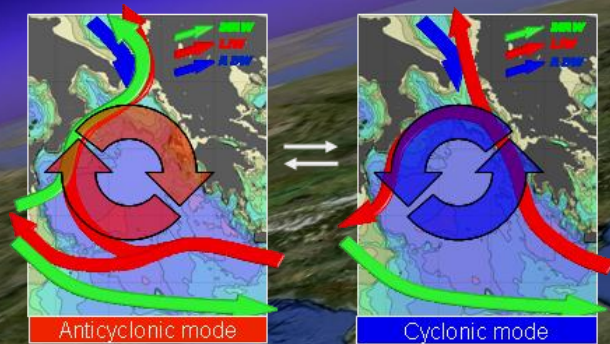
in general...

Water properties and biological variability related to the so-called “*Adriatic ingression*” [Buljan, *AA* 1953], needs to be reconsidered on the light of the BiOS mechanism...

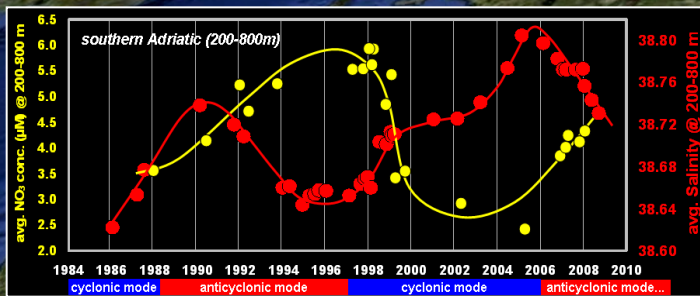




Conclusions



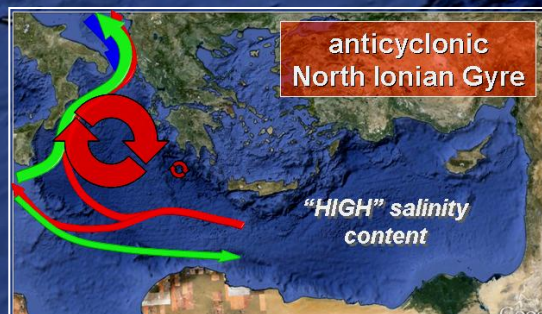
The Adriatic-Ionian Bimodal Oscillating System (BiOS) can be considered the main driving mechanism for the decadal variability of the Ionian circulation.



*The **thermohaline properties** and the **biogeochemical pool** in the Adriatic are affected by the circulation regime in the Ionian, with consequences on the thermohaline cell efficiency and on the productivity.*



*The **biodiversity** patterns are affected by the alternate advection of water of Atlantic and Levantine origin, with consequences on the ecosystems dynamics.*



*The BiOS mechanism could represent a **preconditioning factor** for a “recurrent EMT”.*



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***Thank you for your
attention !***

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