Long term evolution of the Black Sea's environmental conditions and possible link to the assessment of the good environmental status.

Marilaure Grégoire & Arthur Capet

Laboratory of Oceanology, Liege University, Belgium

PERSEUS
POLICY-ORIENTED MARINE ENVIRONMENTAL RESEARCH IN THE SOUTHERN EUROPEAN SEAS

MARES2020, Varna, September 17th 20th 2013.

FOCUS on "bottom hypoxia on the Black sea north-western shelf over 1980-2010: a strong pressure on the ecosystem that compromises GES"

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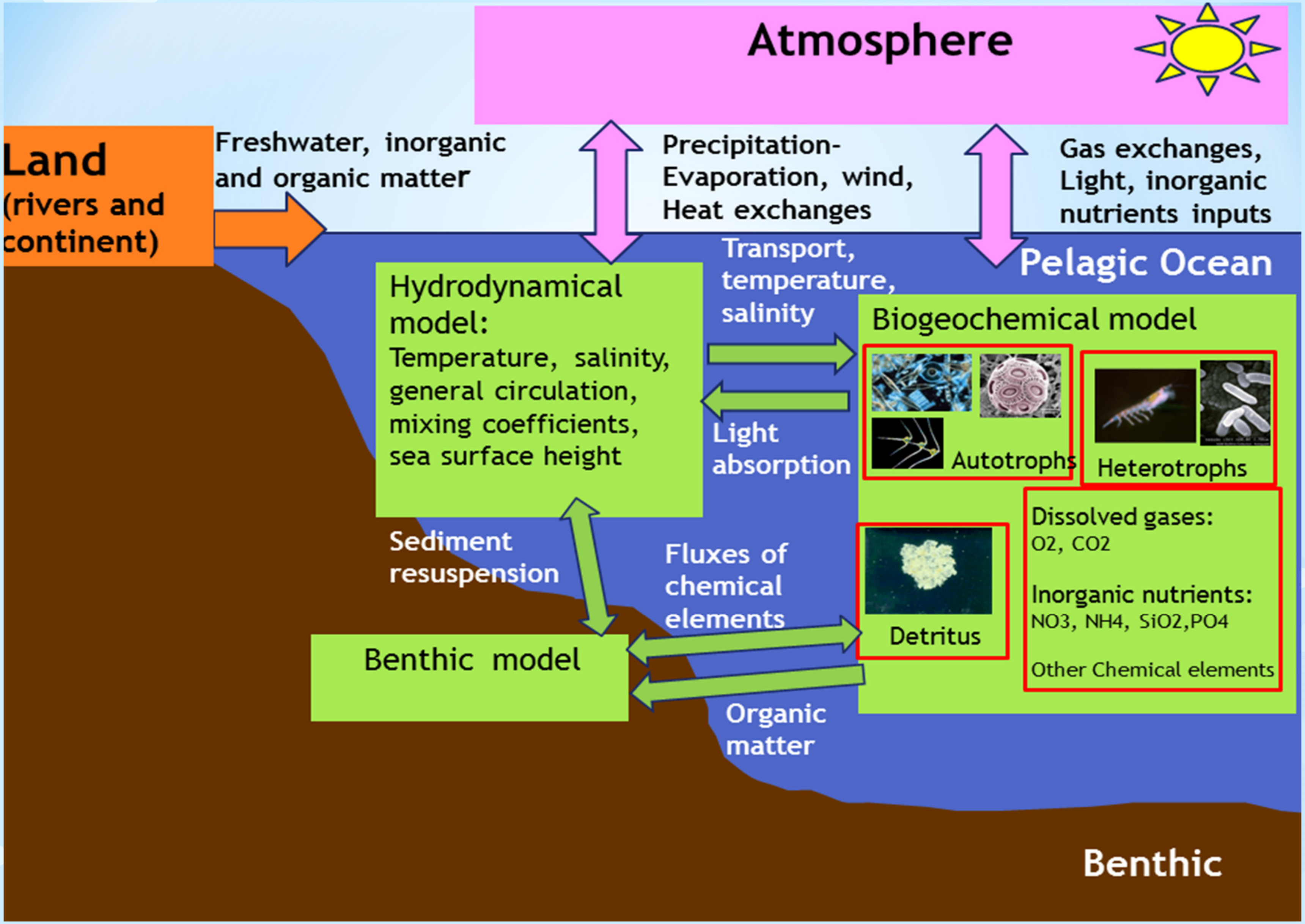
TOOL: 3D Ocean model run for 1980-2010



More details on model description, validation, ...

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Drivers, mechanisms and long-term variability of seasonal hypoxia on the Black Sea northwestern shelf – is there any recovery after eutrophication?

A. Capet[1,2], J.-M. Beckers[1], and M. Grégoire[2]

[1]GeoHydrodynamics and Environmental Research, University of Liège, B5a, 17 allée du 6 Août, 4000 Liège, Belgium
[2]Oceanology Laboratory, University of Liège, B6c, 3 allée de la chimie, 4000 Liége, Belgium

Correspondence to: A. Capet (acapet@ulg.ac.be)

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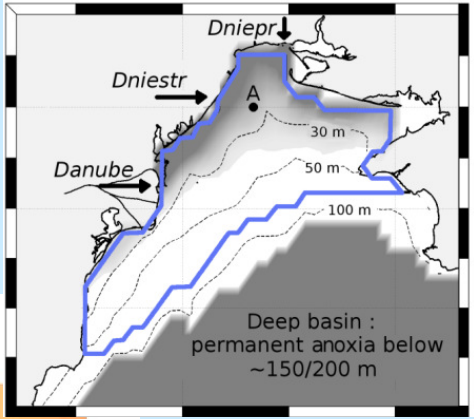
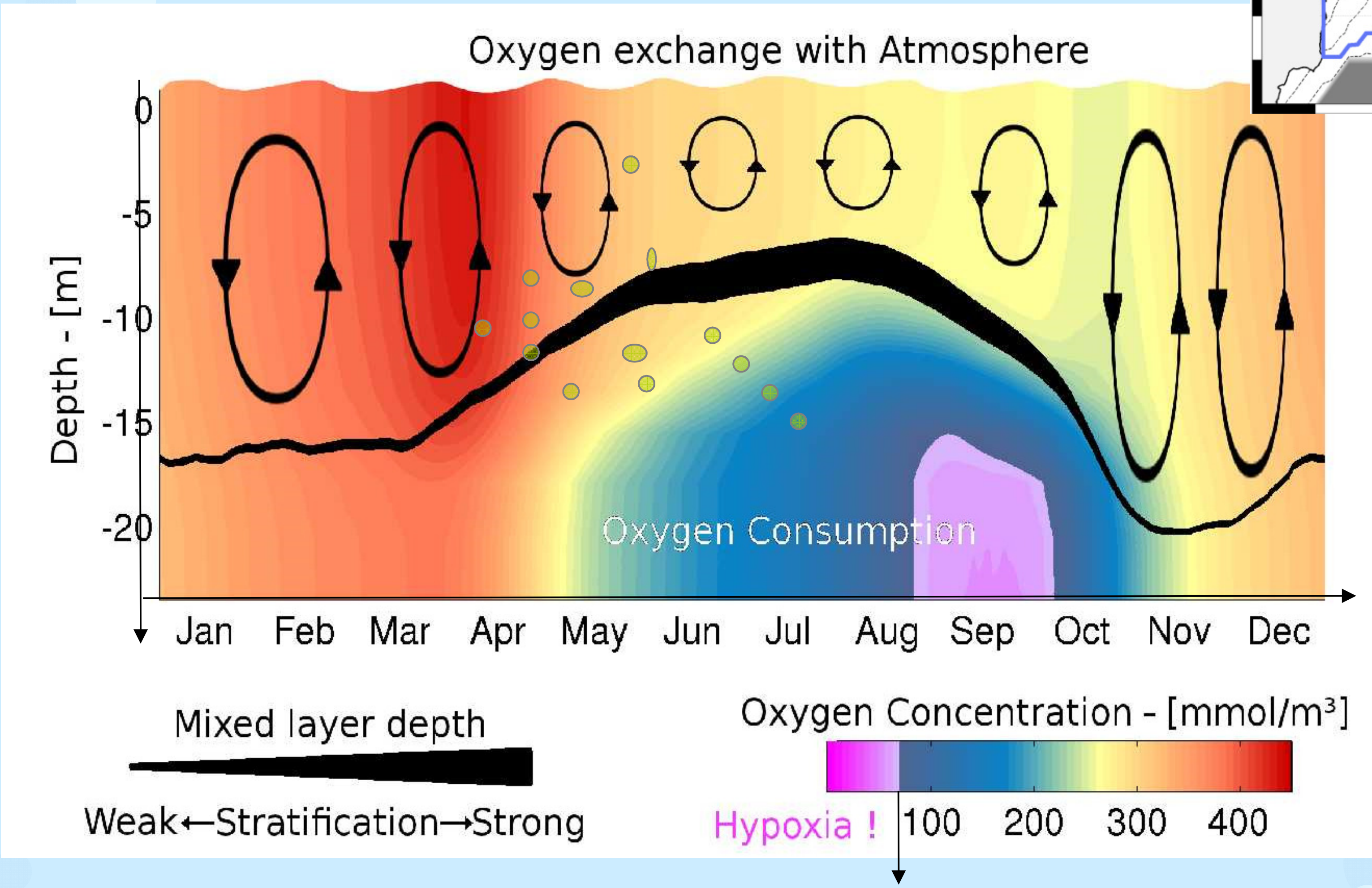
Seasonal Hypoxia: What happens?





Hypoxic threshold : $[O_2]$ < **62 mmol/m³ (2 mg/l)**

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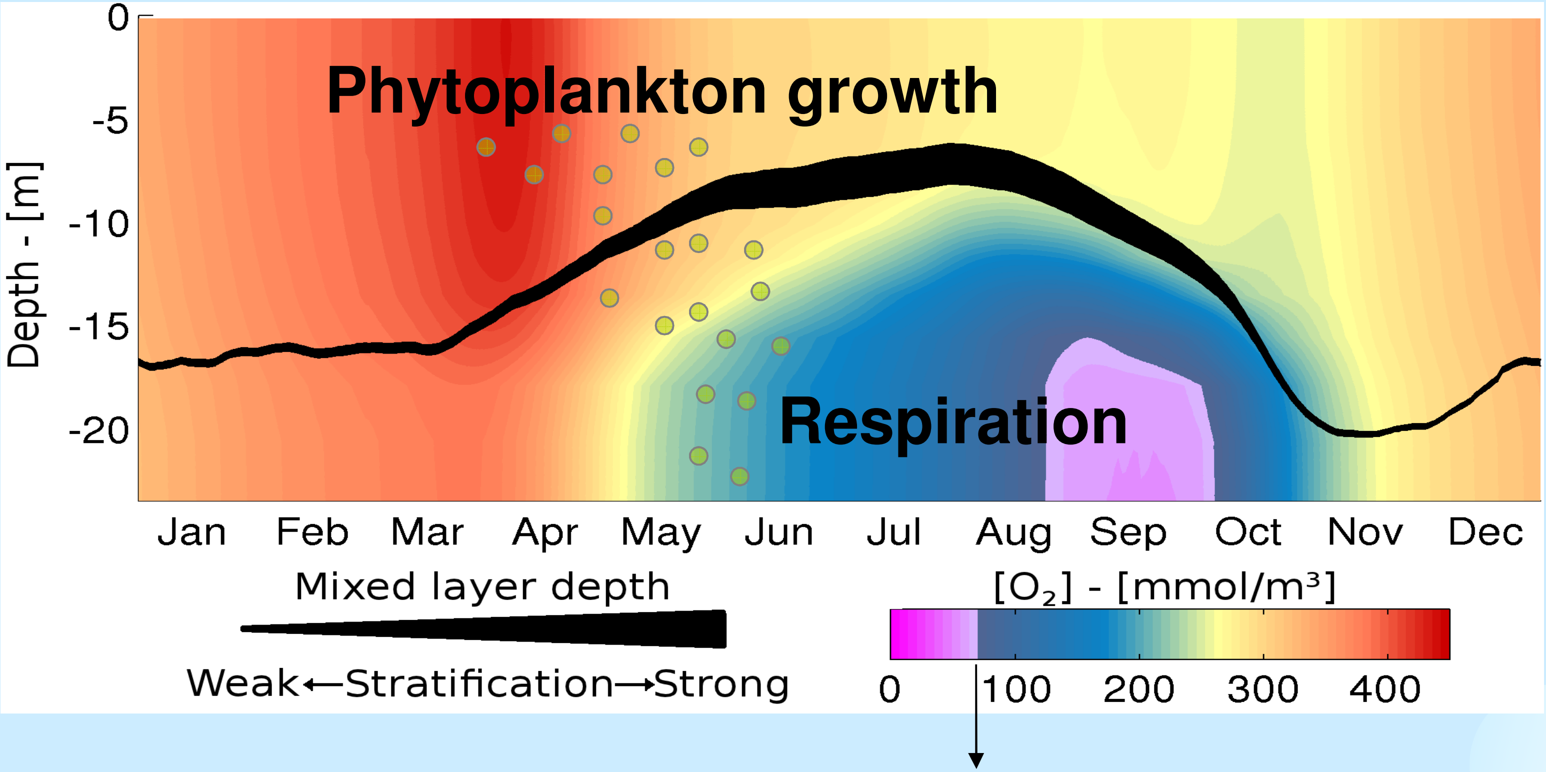

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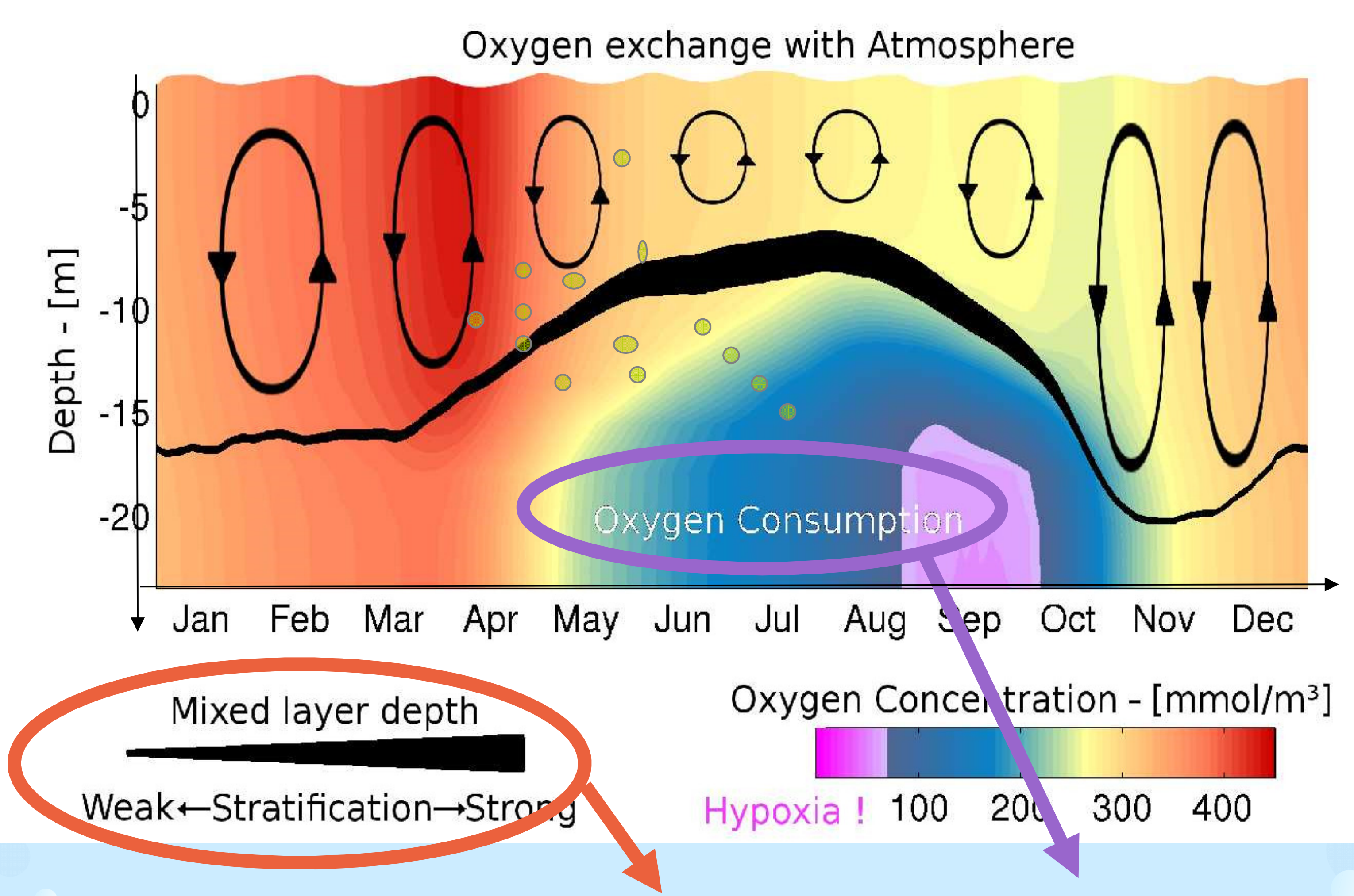

□Sensitive to climate conditions □Sensitive to riverine discharge

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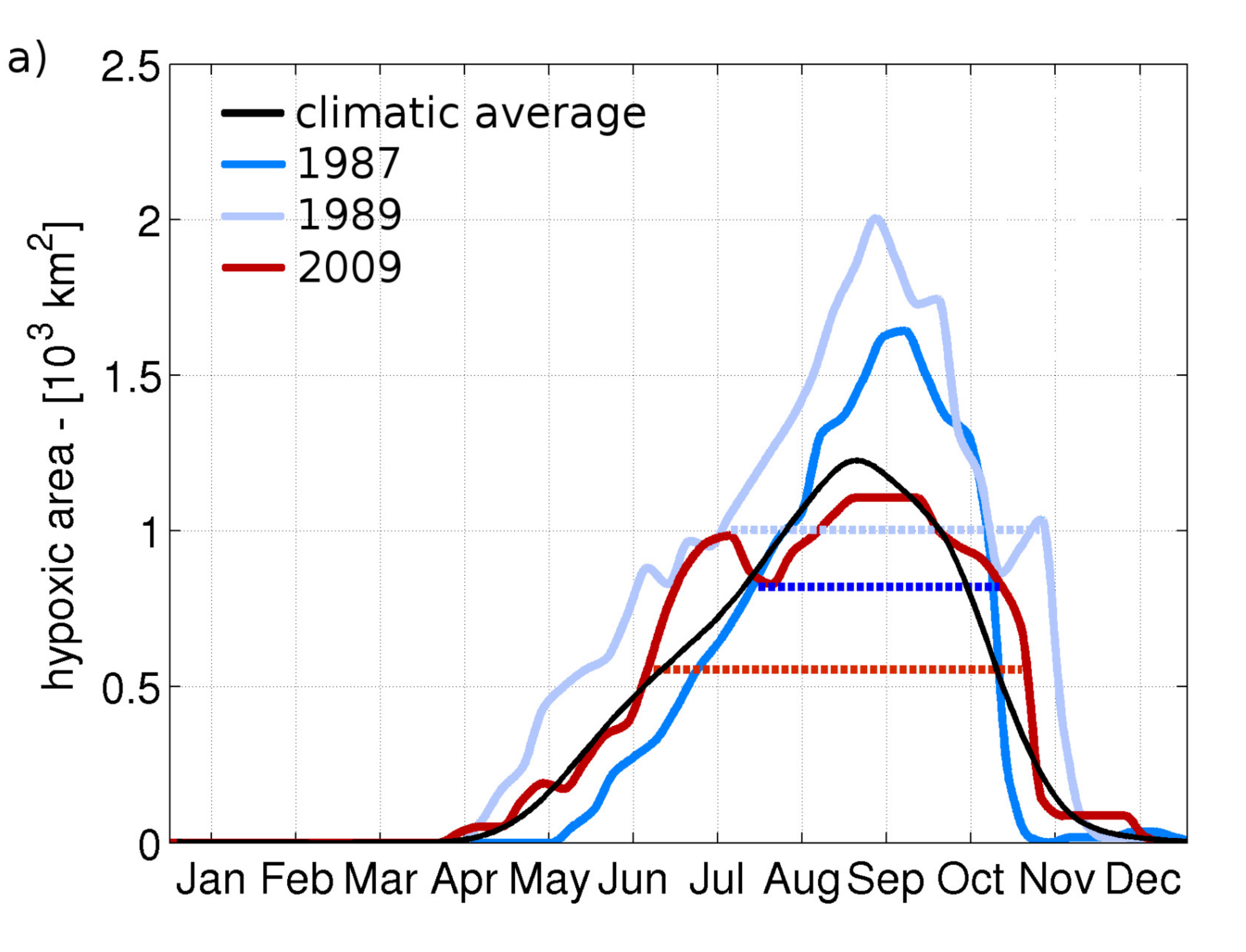
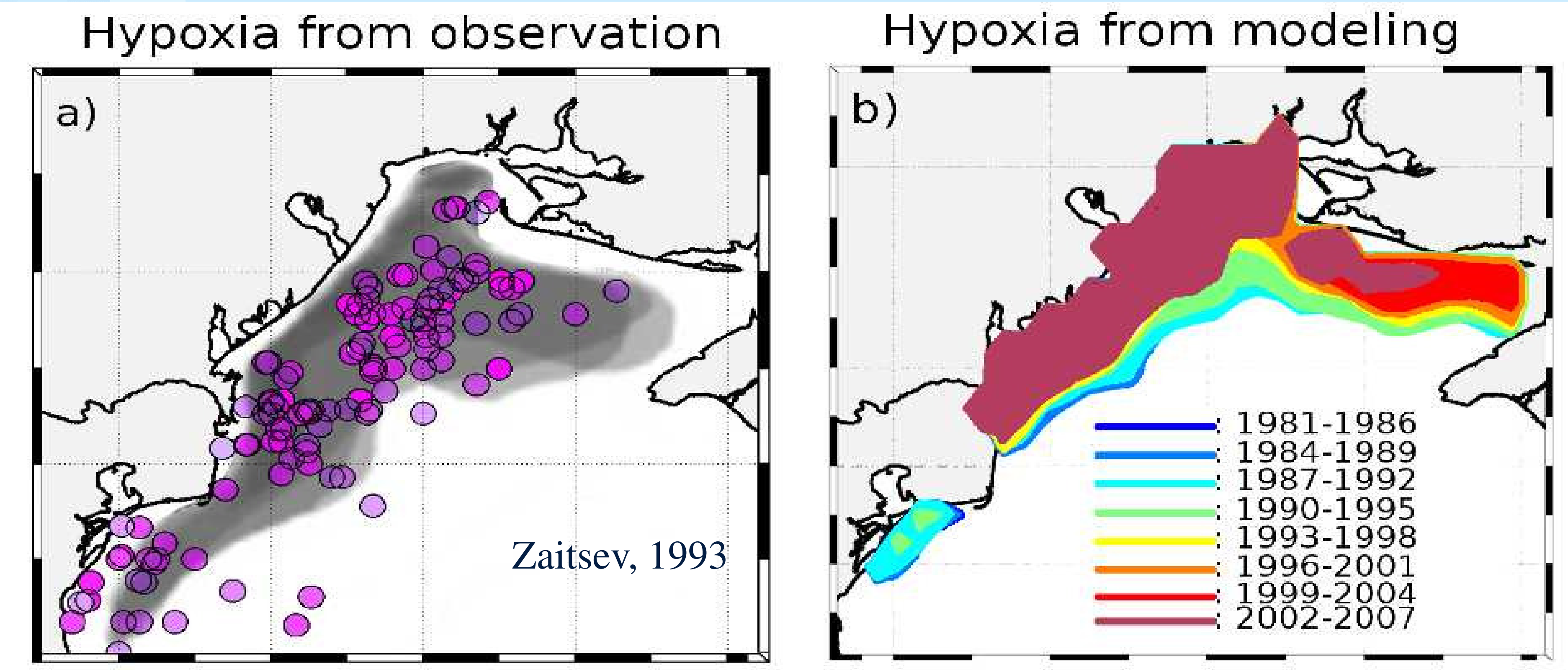
Surface of bottom hypoxic waters over the time





Spatial variability!

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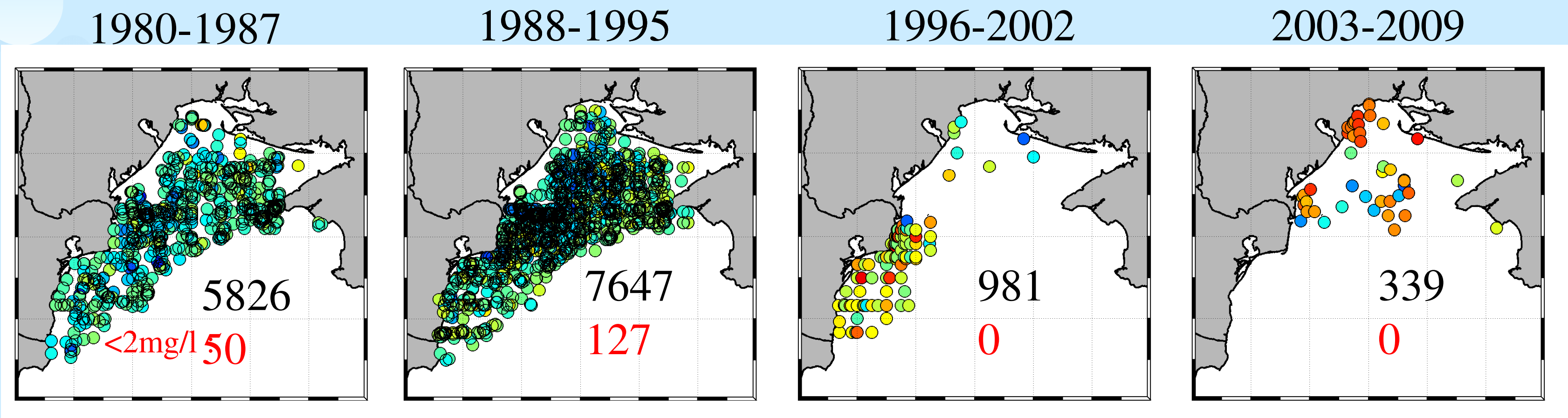
Monitoring of Oxygen 1980-2009 (NATO, MEDAR, WorldOcean,..)

In black: number of data points, in red: number of registered hypoxic events.



It seems that after 1995, there is no hypoxia...

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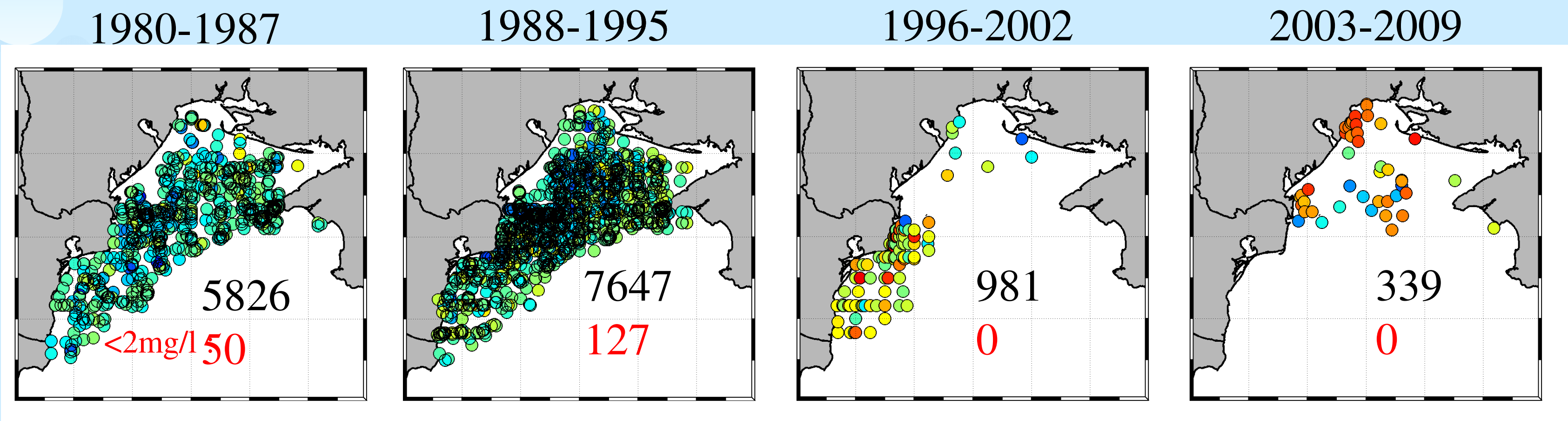
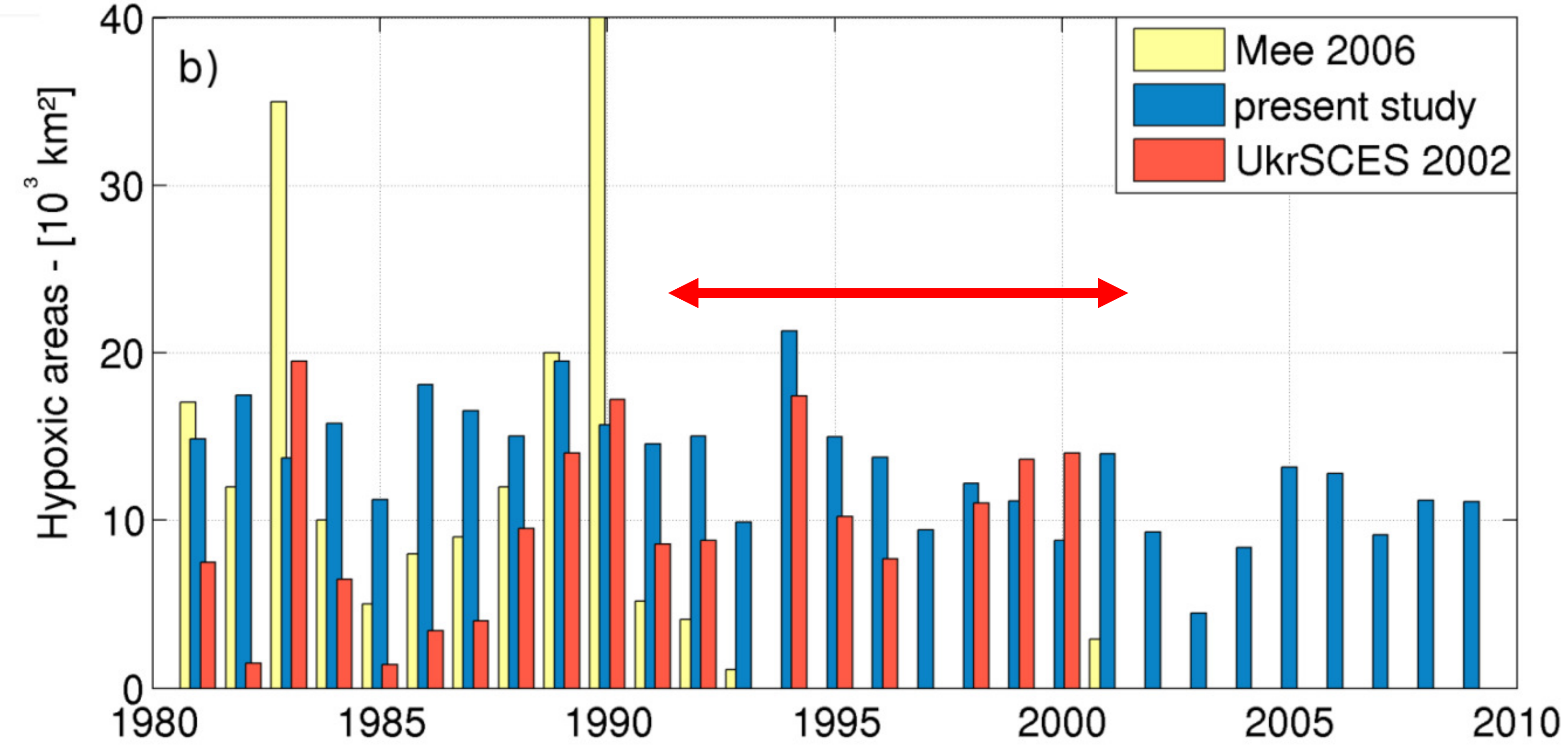


It seems that after 1995, there is no hypoxia...

But, after 1995, no data has been collected during periods and in places where hypoxic events usually occur.

Recovery ? Contrasting conclusions !



Hypoxia is a process highly variable in time (i.e. seasonally & interannually) and space → its monitoring is challenging

Hypoxia status from "in-situ" is sensitive to data distribution. The spatial heterogeneity of the data among years could biased the conclusions on the status of hypoxia.

Dedicated monitoring: A monitoring during the period August-October in the northern part of the Black Sea NWS is recommended.

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How to define an appropriate indicator of hypoxia?

This indicator has to consider that:

- Hypoxia is a process highly variable in space and time (limitation of defining hypoxia by a snapshot map !)

- LINK with GES: For living organisms, the duration of the hypoxia event is a critical factor (Vaquer-Sunyer and Duarte, 2008). It means that the hypoxia index has to involve an information on the **duration** of the hypoxic event.

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→ To quantify the severity of hypoxia we need an index that merges an information on both the temporal (duration) and spatial aspects of hypoxia.

It is very difficult to have an information on the temporal and spatial aspects of hypoxia. Modeling tool can provide such an information.

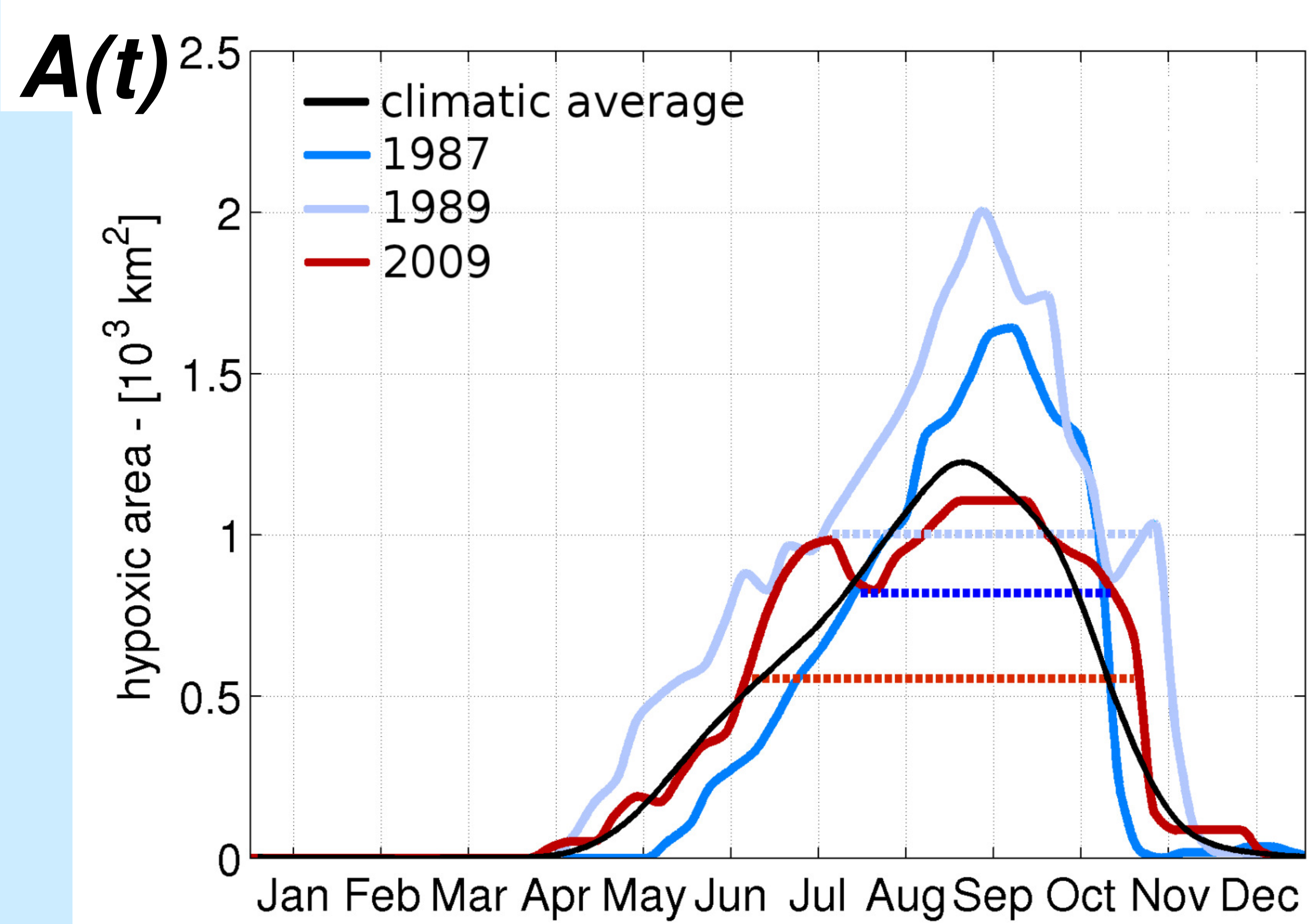
Definition of an index of Hypoxia

Time scale:

$$D = \frac{1}{\max A(t)} \int_{year} A(t)dt,$$

Hypoxia index:

$$H = \frac{1}{D} \int_{year} A(t)dt,$$



$$D = \frac{1}{\max A(t)} \int_{year} A(t)dt,$$

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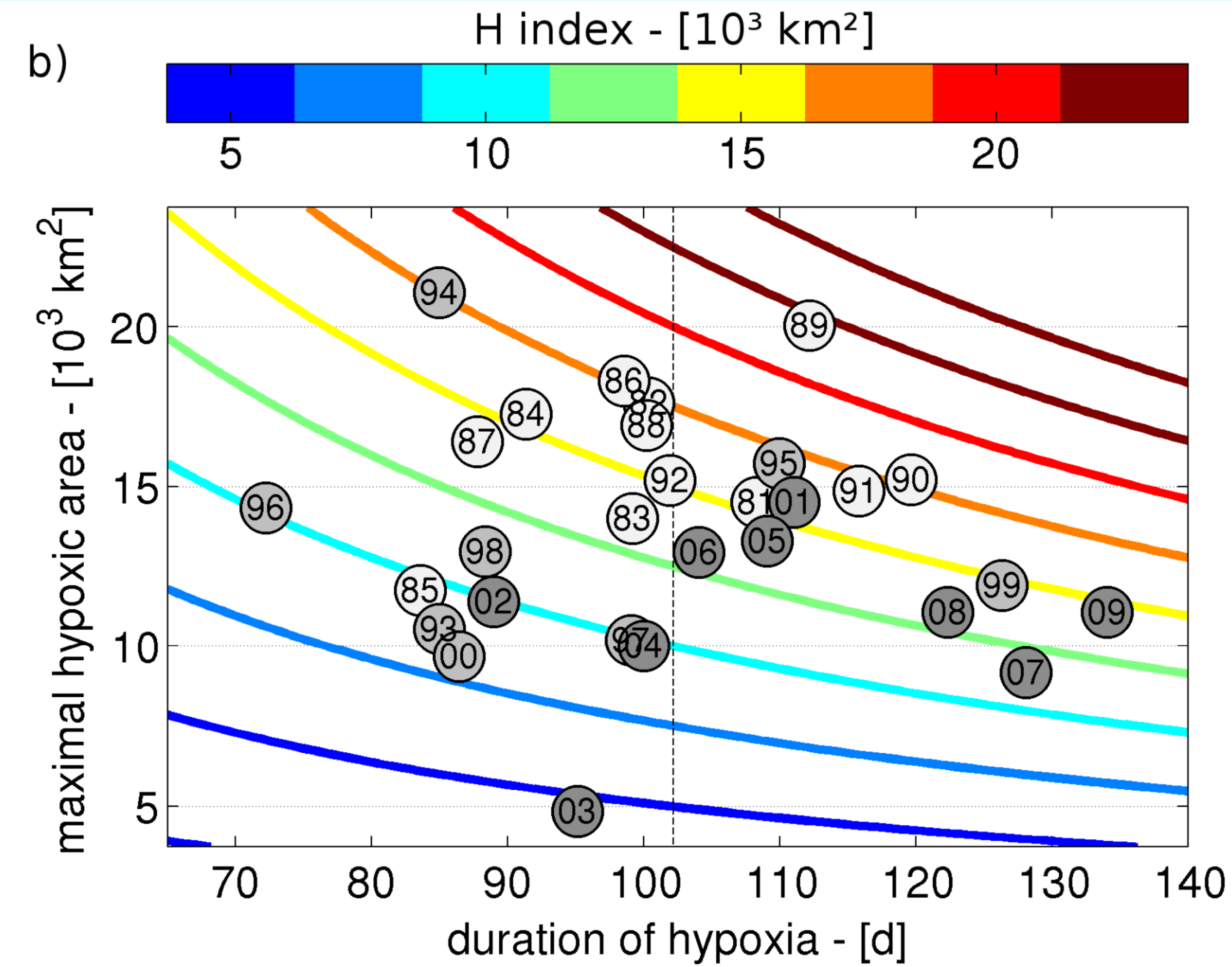

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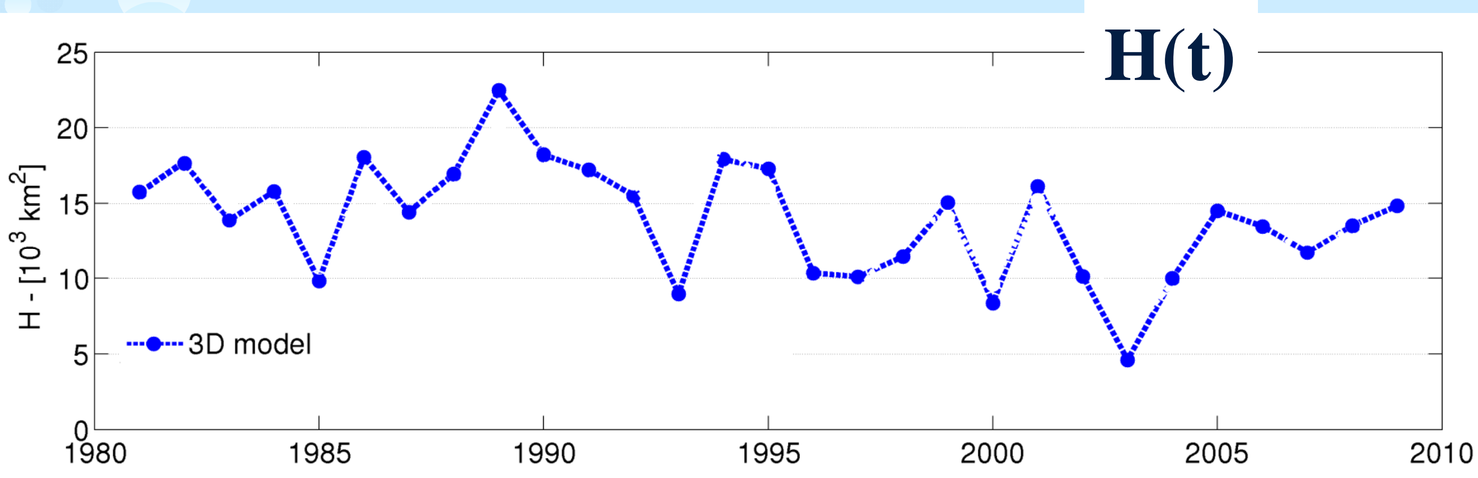
Long term evolution of H



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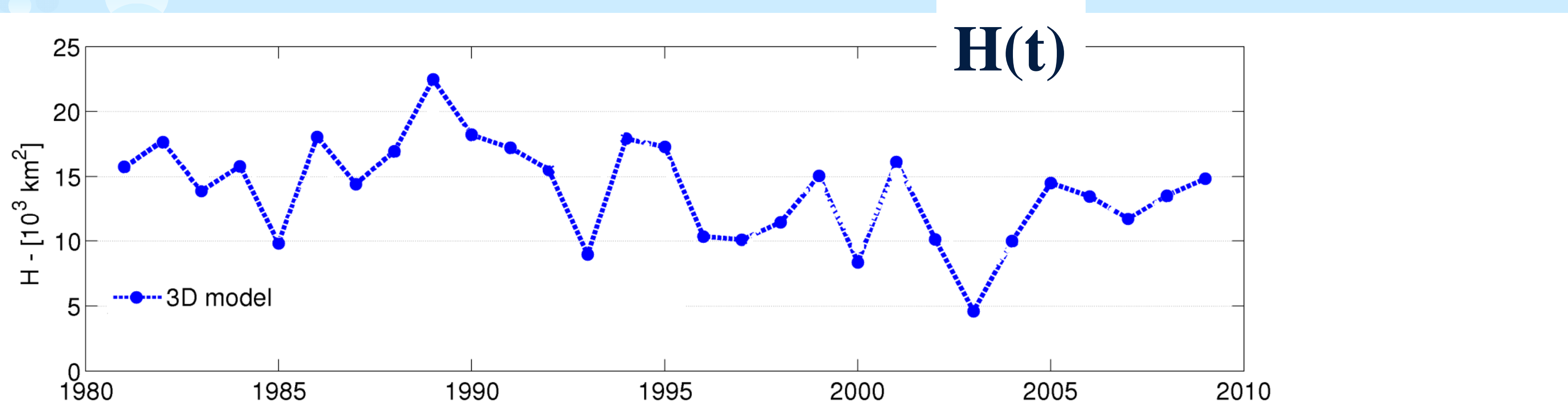
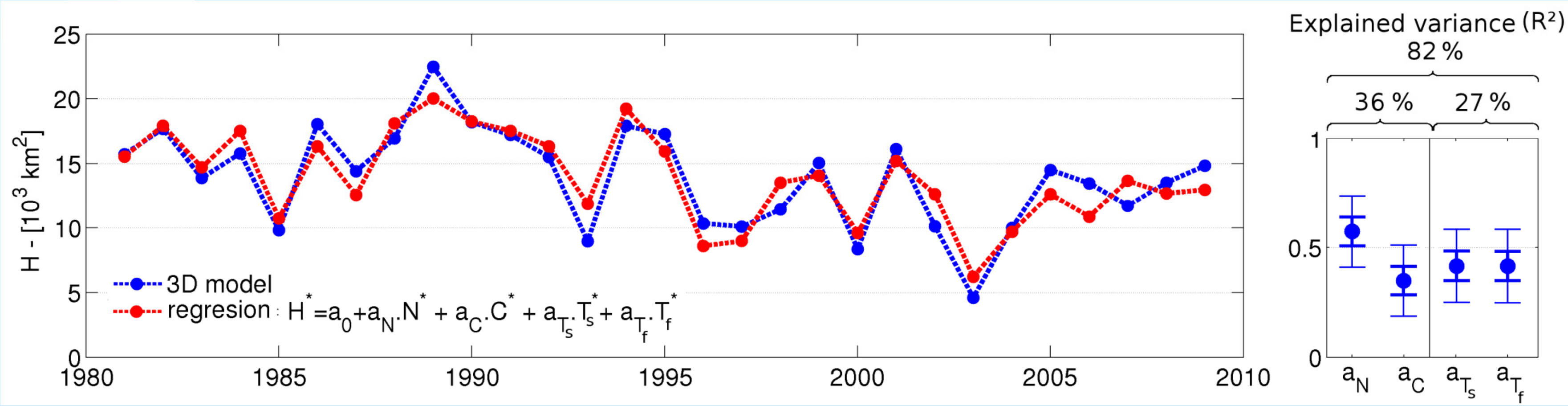


Approach:

Statistics (Multiple linear regression model) to identify among a large set of simulated variables those that explain the variability of H

Drivers of interannual variability of H



Drivers

Eutrophication

N : riverine Nitrogen load

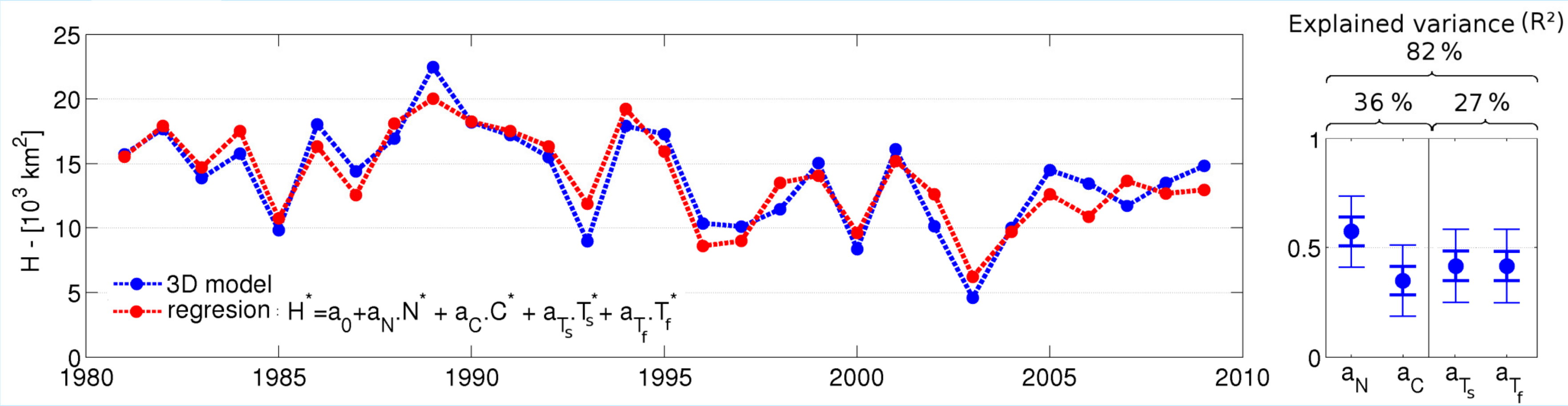
C : Accumulation of organic matter in the sediments

Climatic

Ts : Sea surface temperature in early spring

Tf : Sea surface temperature in late summer

Drivers of interannual variability of H



Role of the drivers:

- Both climate and eutrophication related factors have a similar impact on the variability of H
- Climatic drivers mostly drive a shorter timescale variability while eutrophication drivers act on a longer term.
- Climate factors mainly impact the duration of the hypoxic event while eutrophication factors act on the maximum surface covered by hypoxia (two aspects of H).

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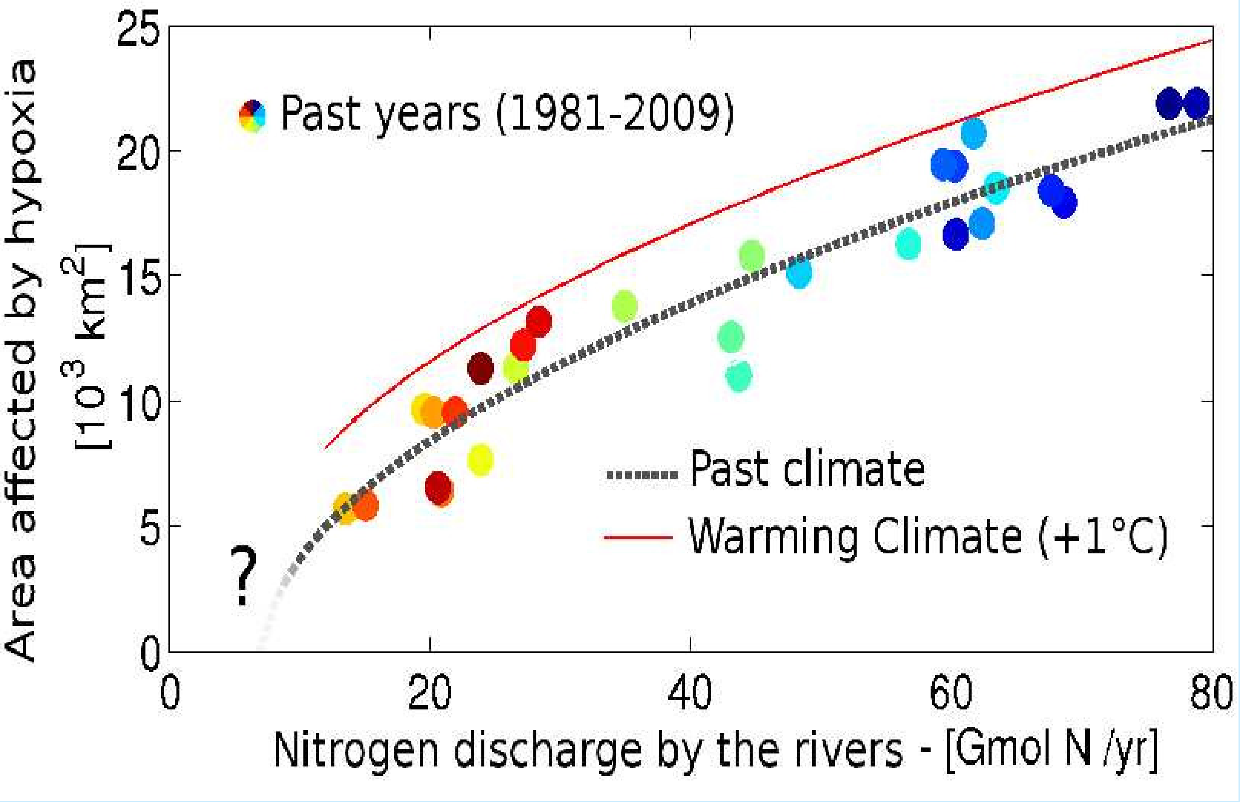
How does the climate mitigate the recovering from hypoxia after nutrients reduction?

Climate factors are mainly responsible for the high values of H occurring in the last decade (2000-2009). This stresses that a possible climate change will complicate the management of hypoxia trough riverine load restriction policies.



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What is the time scale of recovery of the system submitted to eutrophication due to the sediment inertia?

During years of high nutrient loads, the semi-labile stock accumulates year after year and continues to cause oxygen consumption several years after high riverine load events (~9 years)

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How to link hypoxia level and GES?

Lethal and non-lethal effects of low oxygen concentrations on living organisms strongly depend on the tolerance of the considered species of the low level of oxygen concentration and of the duration of the hypoxic event (Vaquer-Sunyer and Duarte, 2008). Hence, the choice of a sustainable level of H that meets GES is therefore a very delicate issue which requires the combination of appropriate tools, as well as dedicated and site-specific studies.

Questions-Answers:

5) How to link hypoxia level and GES?

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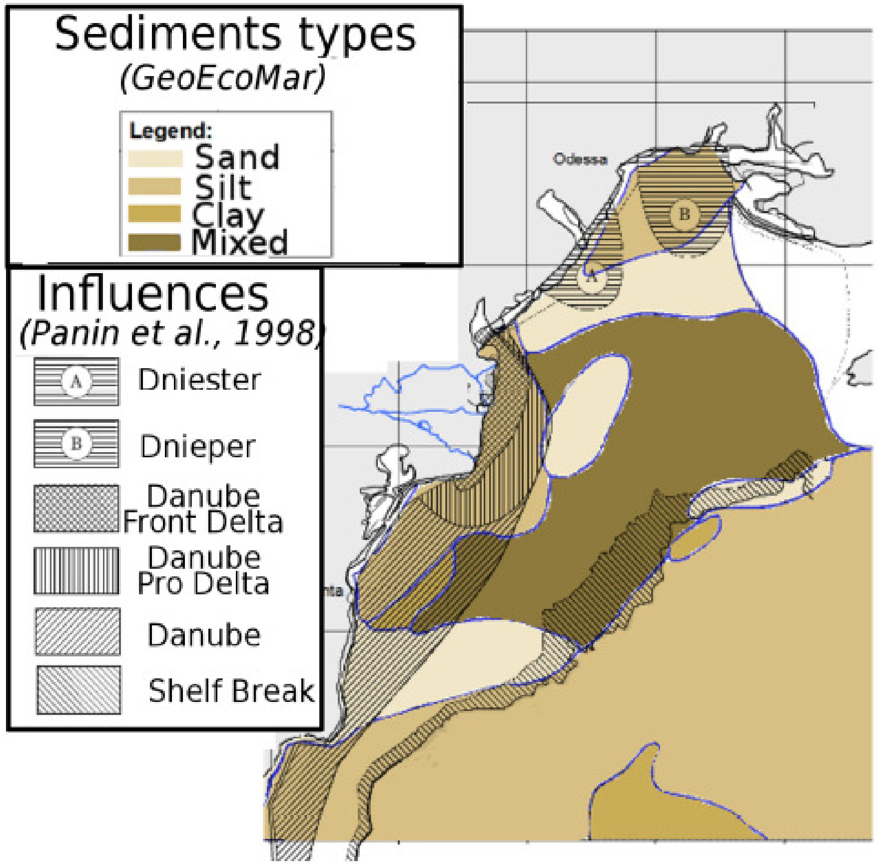
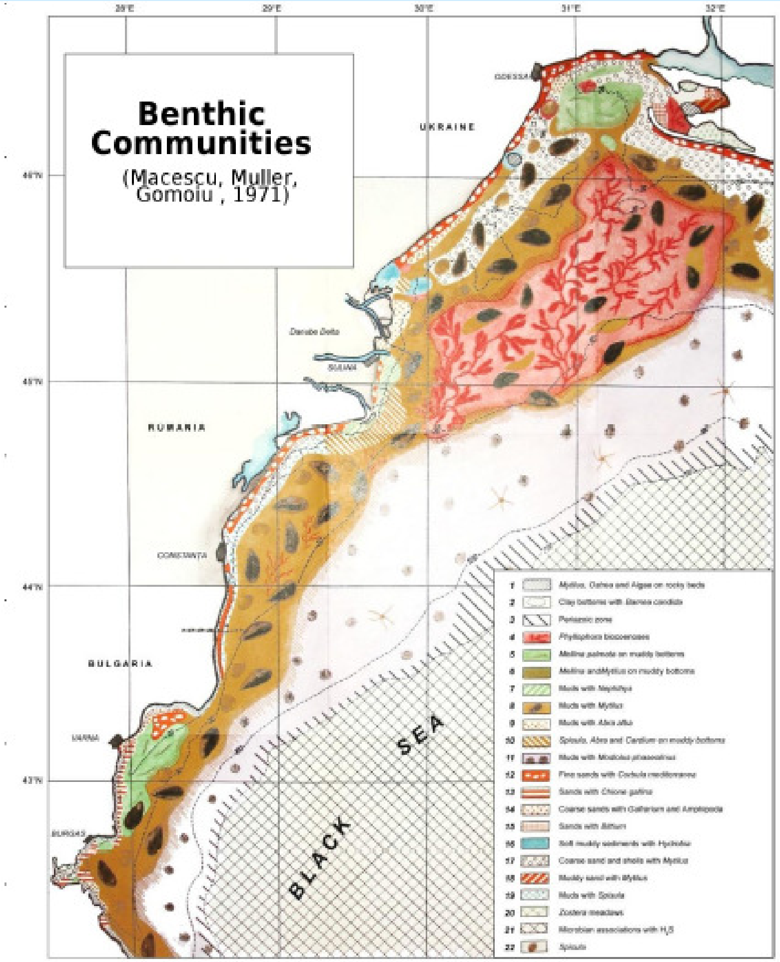
So we still miss something if we want to connect with biodiversity

Mutual interactions between environmental conditions and the benthos





Thank you for your attention!

46th Liege colloquium May 5th-9th 2014
Low oxygen environments in marine, estuarine and fresh waters

http://modb.oce.ulg.ac.be/colloquium/

Thematic Sessions & Keynote speakers

1. Deoxygenation, marine resources, ecosystem functioning and structure of the foodweb.
2. Deoxygenation and biogeochemical cycles
3. Life and processes in redox gradients
4. Paleoproxies of hypoxia
5. Modelling hypoxia.
6. Oxygen time series and instrumental developments:
7. Eastern Boundary upwelling systems (EBUS) as natural SOLAS laboratories
8. Deoxygenation in a global change context.

Keynote talks: R Rosenberg, R. Diaz, D. Canfield, N. Rabalais, S. Severmann**.**

Scientific committee: S. Ashby, H. Bange, A. Borges, C. Borrego, S. Bouillon, A. Capet, F.Chavez, D. Conley, S. Crowe, B. Currie, J.P. Descy, A. Devol, B. Dewitte, V. Garçon, M. Grégoire, D. Gutierrez Aguilar, S.Hallam, J.M. Hernandez-Ayon, K. Jurgens, S. Konovalov, A. Kostianoy, L. Legendre, L. Levin, F. Meysman, J. Middelburg, W. Naqvi, T. Oguz, A. Oschlies, A. Paulmier, C. Robinson, C. Slomp, B. Thamdrup. J. Zhang.