Study of the plankton ecosystem variability using Modelling and BioArgo floats deployment in the Mediterranean Sea

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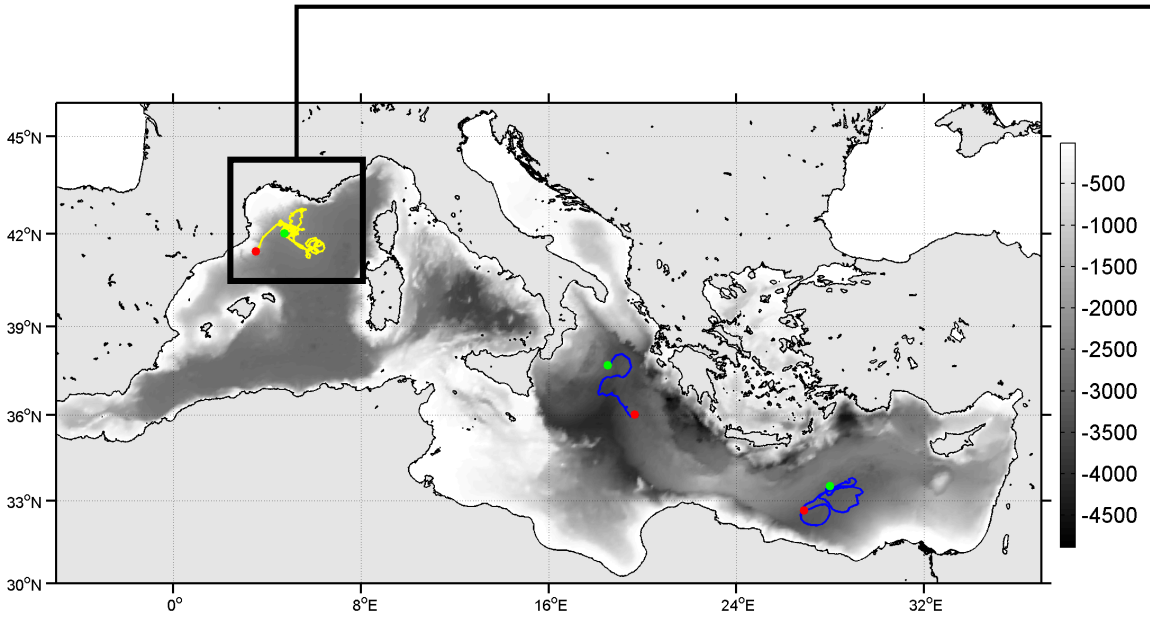
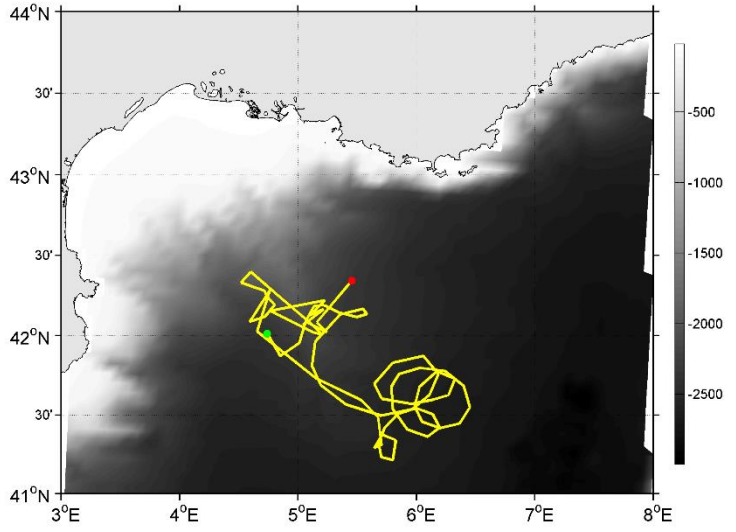
BioArgo Floats deployment and objectives

Objectives

Biochemical Functioning of the Mediterranean Sea

NW Seasonal evolution and Mesoscale processes



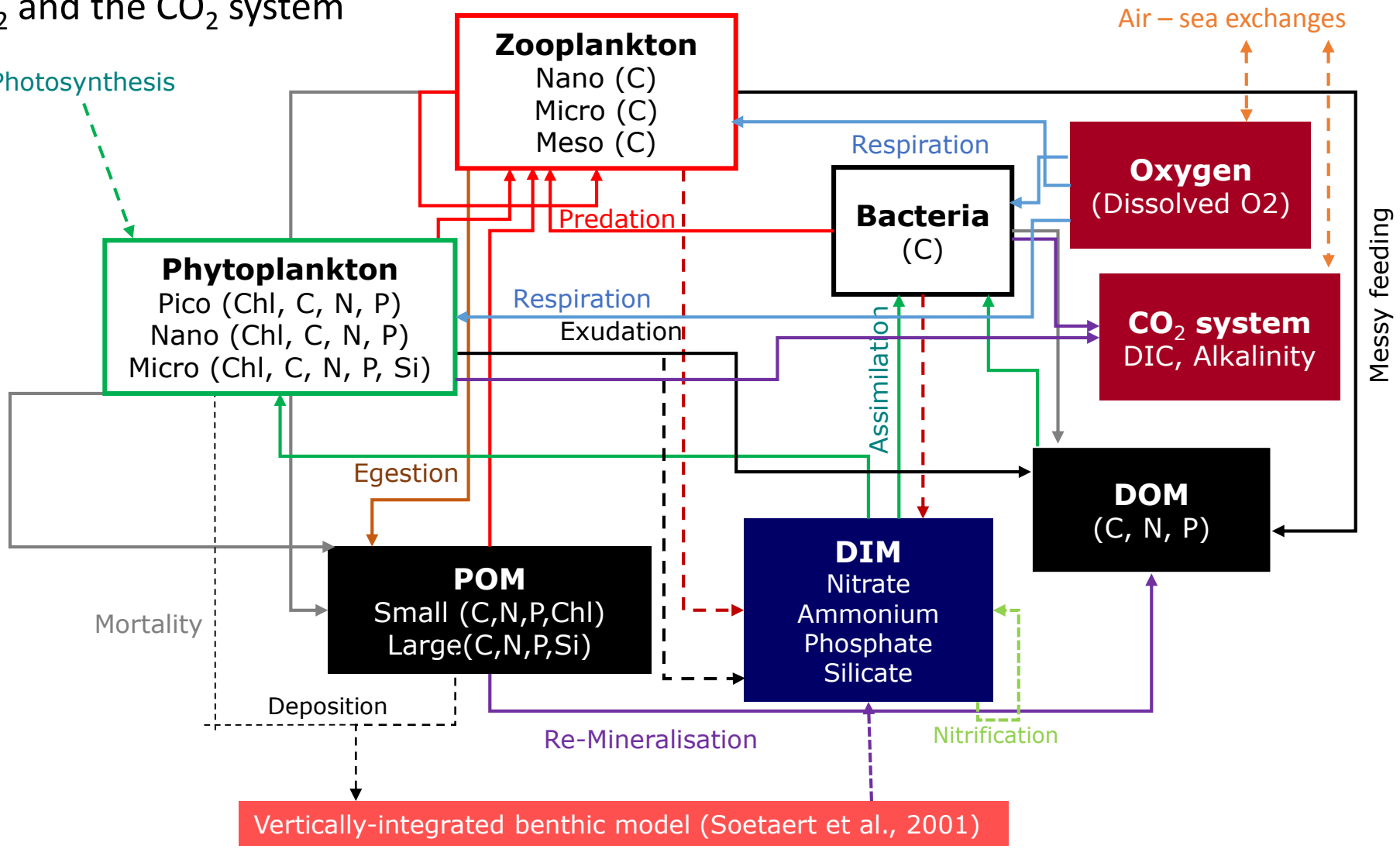


Global overview of Chlorophyll Seasonal Cycle

North-Western Restratification Evolution

Biogeochemical Model

Eco3m-S (extended version from the model described by Auger et al. (2014)) : C, N, P, Si cycles, variable intern ratios of the phytoplankton groups, uploading the dissolved O_2 and the CO_2 system

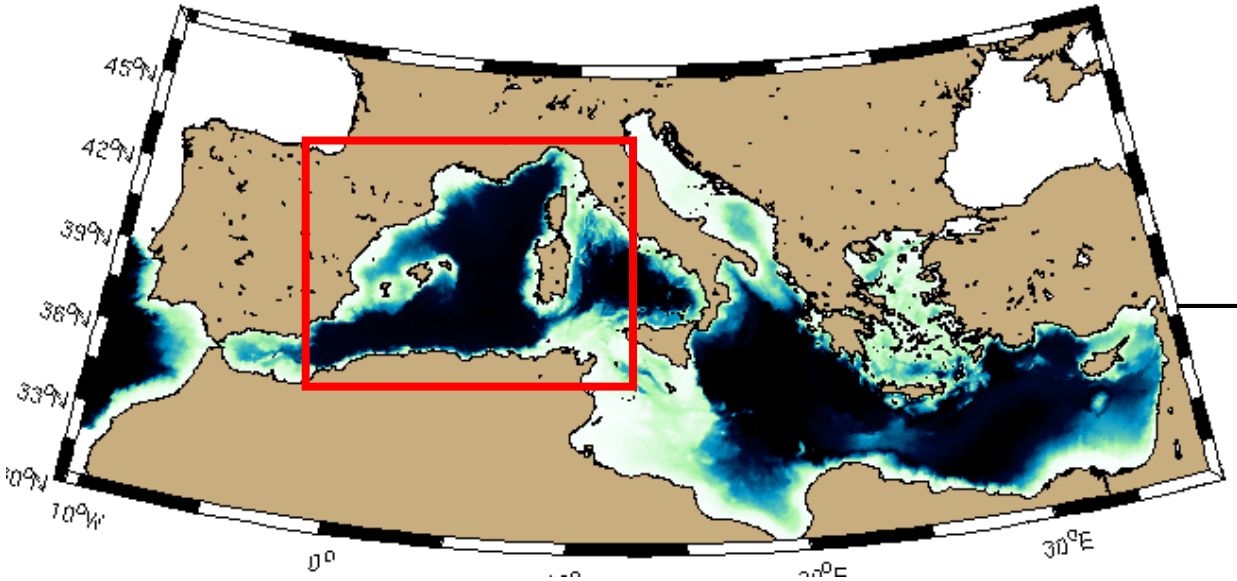


RESOLUTION
1/12° ~ 7 Km

Atmospheric forcing
ALADIN (12km)/ECMWF (1°/8, 3h)

Mercator Ocean
Ocean Forecasters

Hydrodynamics
NEMOMed12/PSY2V2R4
2000-2013/2010-2014



Grid:
3D
75/50 levels

Atlantic Open Boundary
WOA climatology datasets

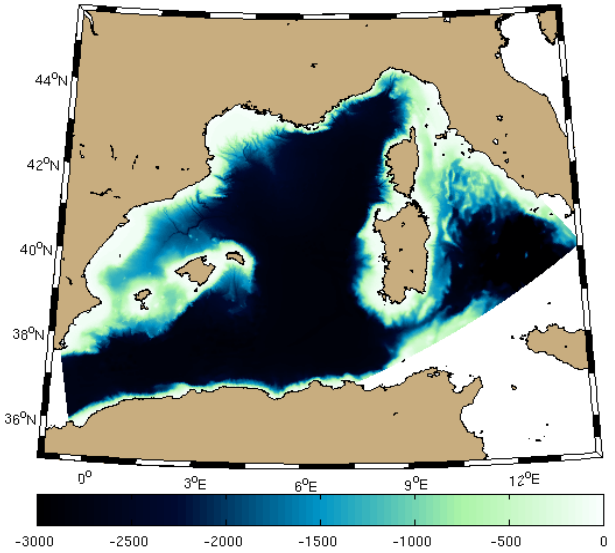
Bio Initializing
Datasets from MEDAR/MEDATLAS (Lavezza et al., 2011)

Rivers inputs
34 rivers
+ other runoff
Ludwig et al. (2010)

RESOLUTION
1/111° ~ 1 Km

Atmospheric forcing :
ECMWF (1°/8, 3h)

Hydrodynamics:
Symphonie S26

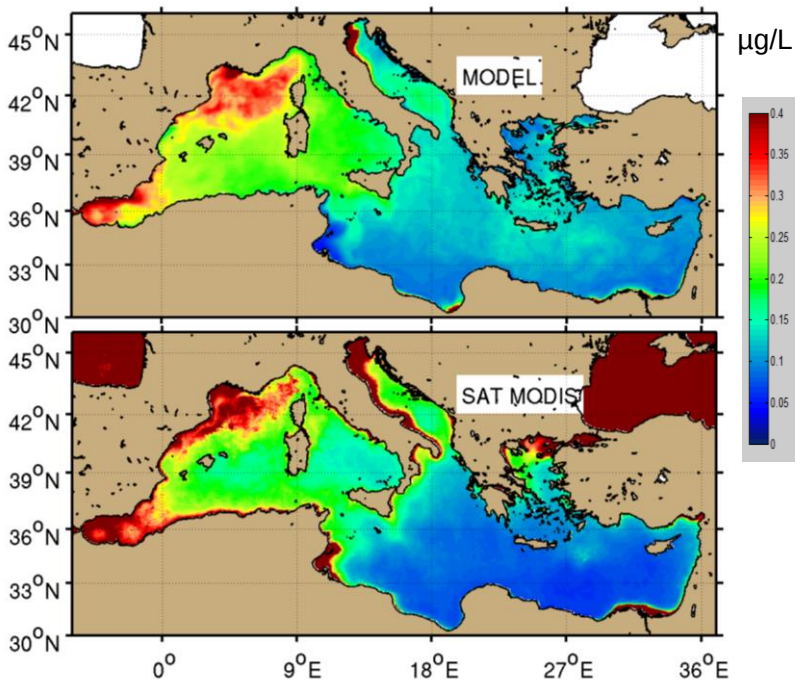


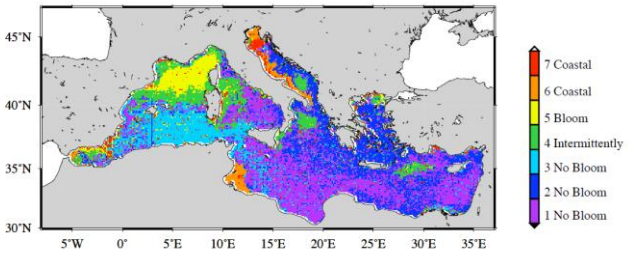
Initializing / Consistent physical and biogeochemical boundaries forcing
Previous global Mediterranean model

Rivers inputs :
15 Rivers
(Daily data series in the Rhône river, pers. comm. P. Raimbault)
+ other rivers from Ludwig et al. (2010)

Grid:
3D C-grid
40 levels

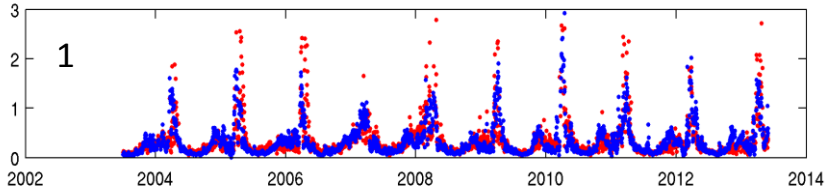
Surface Chlorophyll Concentrations





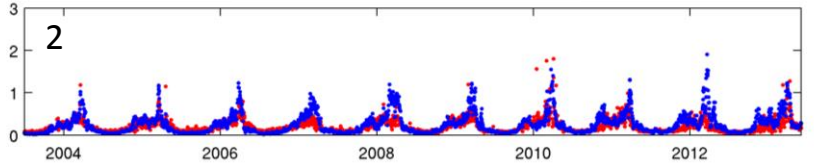
F. D'Ortenzio and M. Ribera d'Alcalà, 2009

Provencal Sea



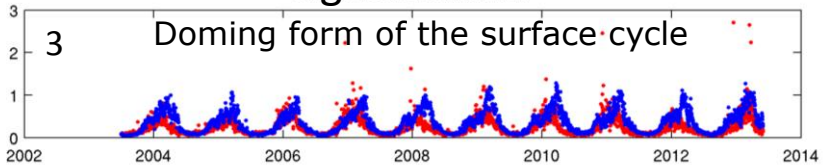
Important peaks in spring

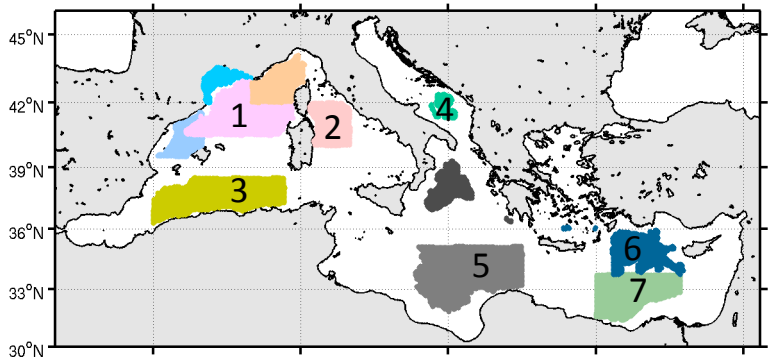
Tyrrhenian Sea



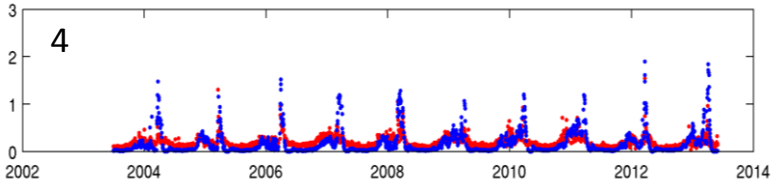
Algerian Basin

Doming form of the surface cycle

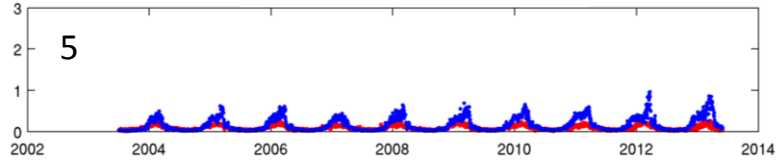




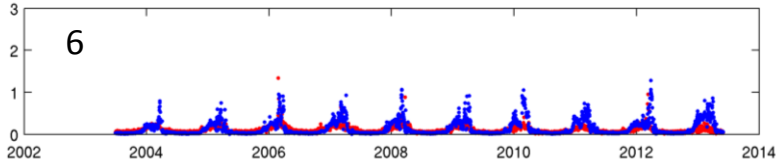
Adriatic Sea



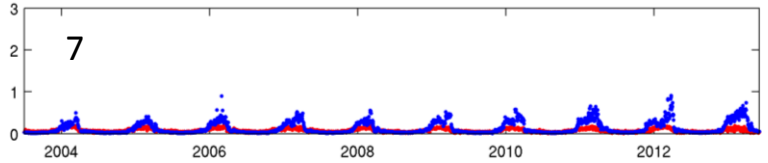
South Ionian sub basin



North Levantine sub basin



South Levantine sub basin

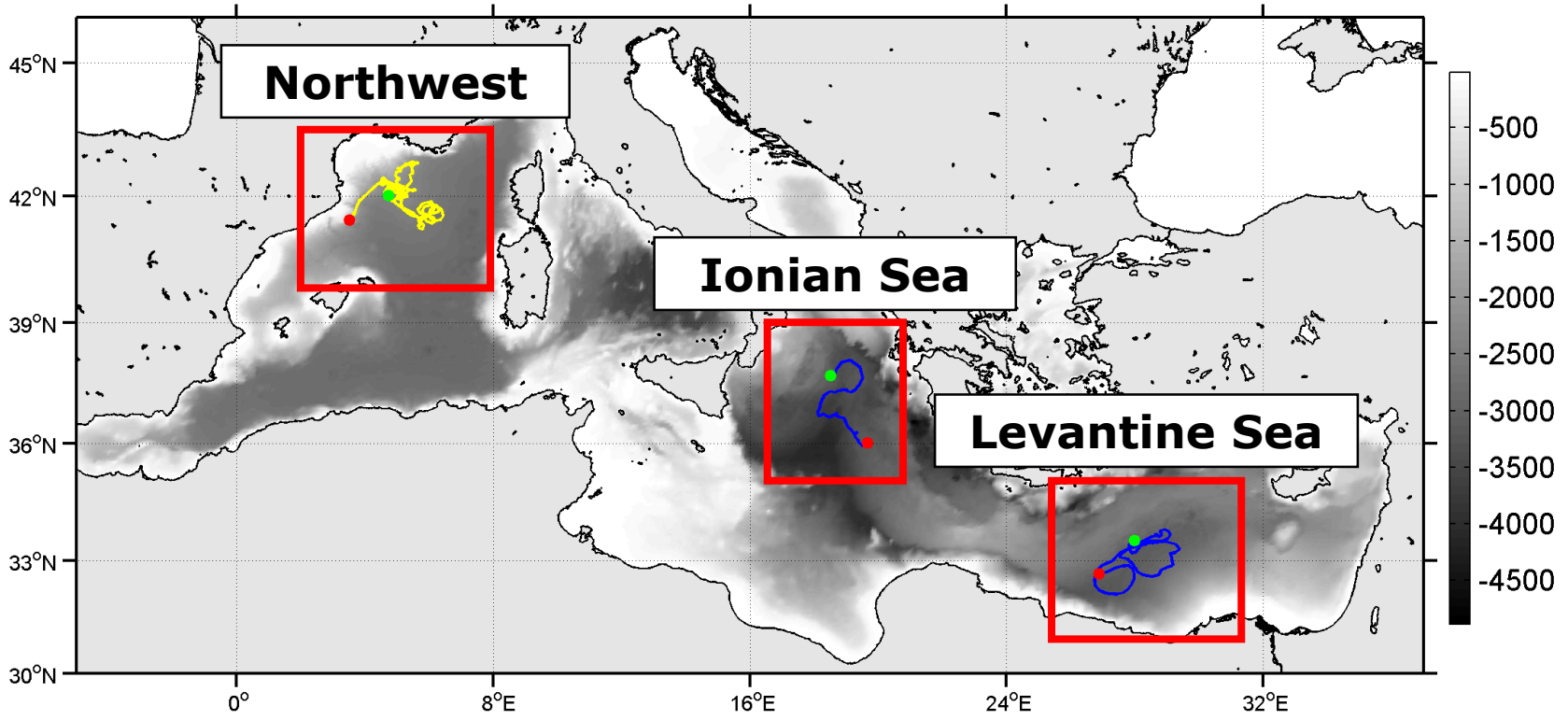


4km Modis Satellite product

Model

PART 1

Global overview
Seasonal cycle



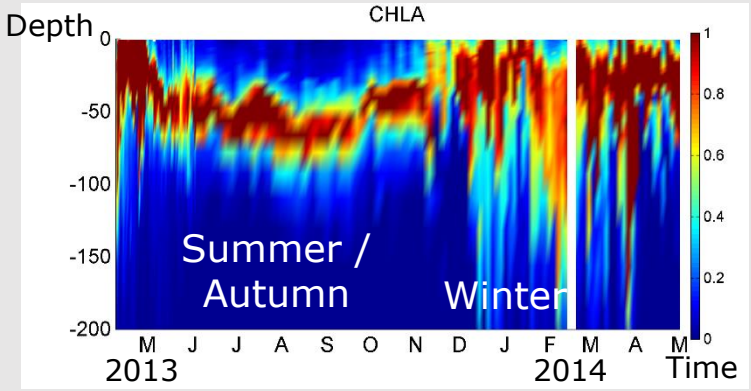
Biochemical Functioning of the Mediterranean Sea

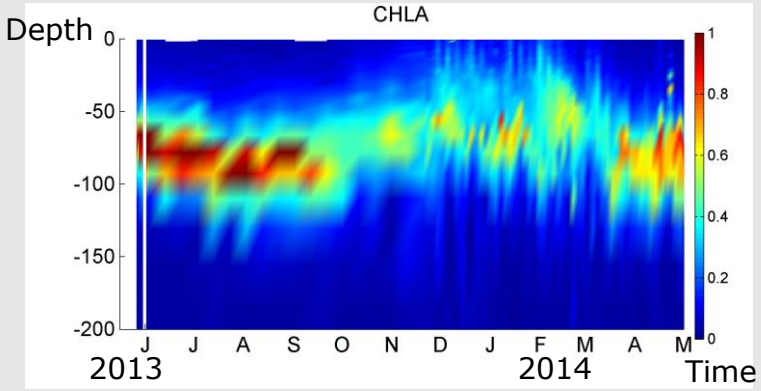
Northwest

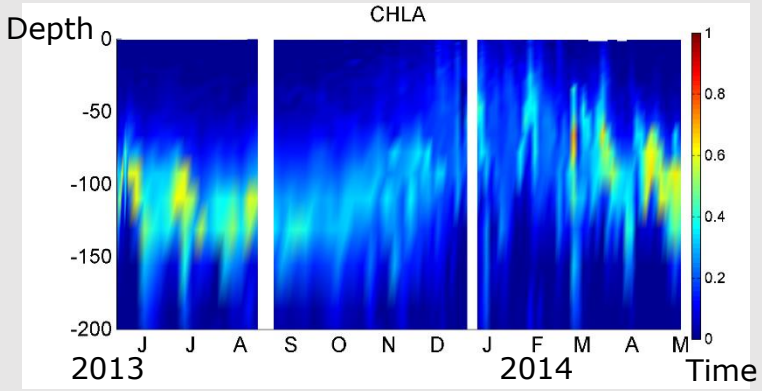
Ionian Sea

Levantine Sea

FLOATS







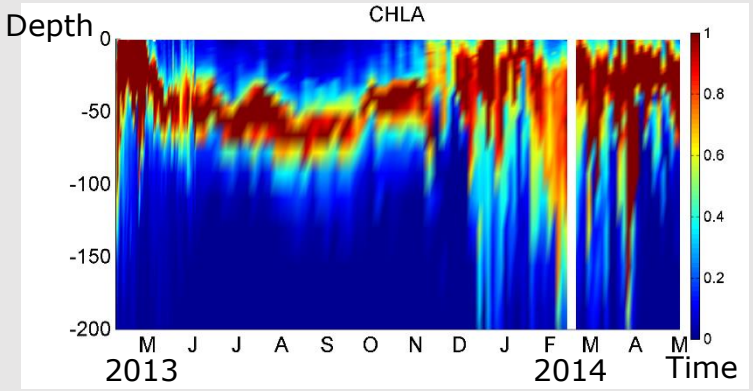
- Annual cycle
- West to east deepening of the chlorophyll maximum depth (DCM)
- West to east DCM intensity diminishing (assumption.. Waiting for calibrated data)

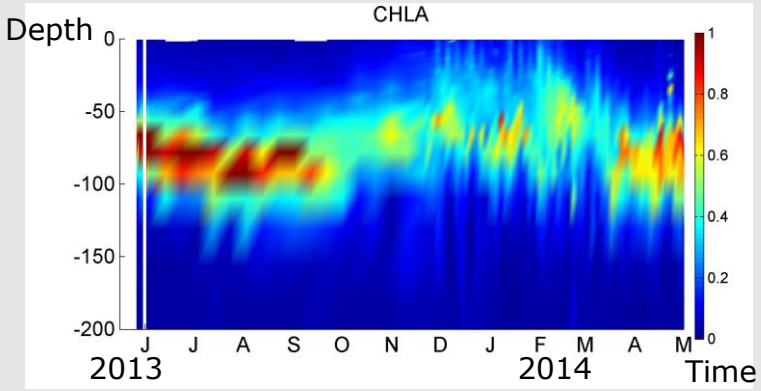
Northwest

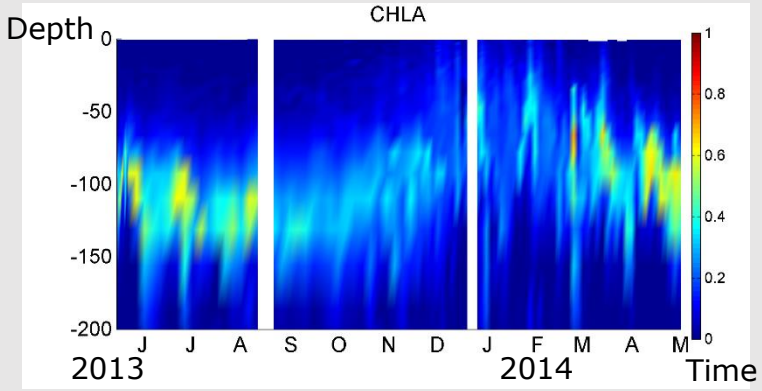
Ionian Sea

Levantine Sea

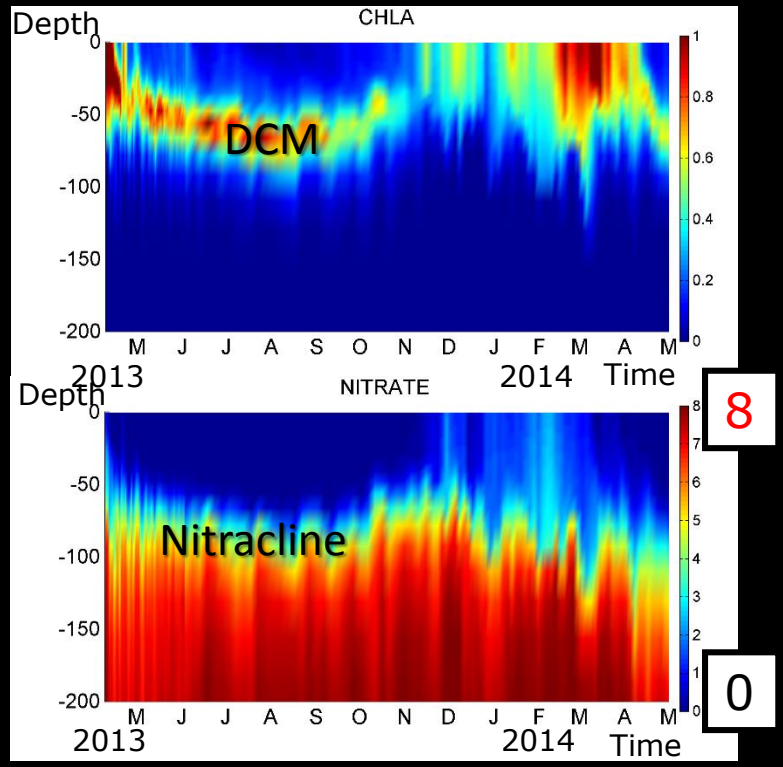
FLOATS

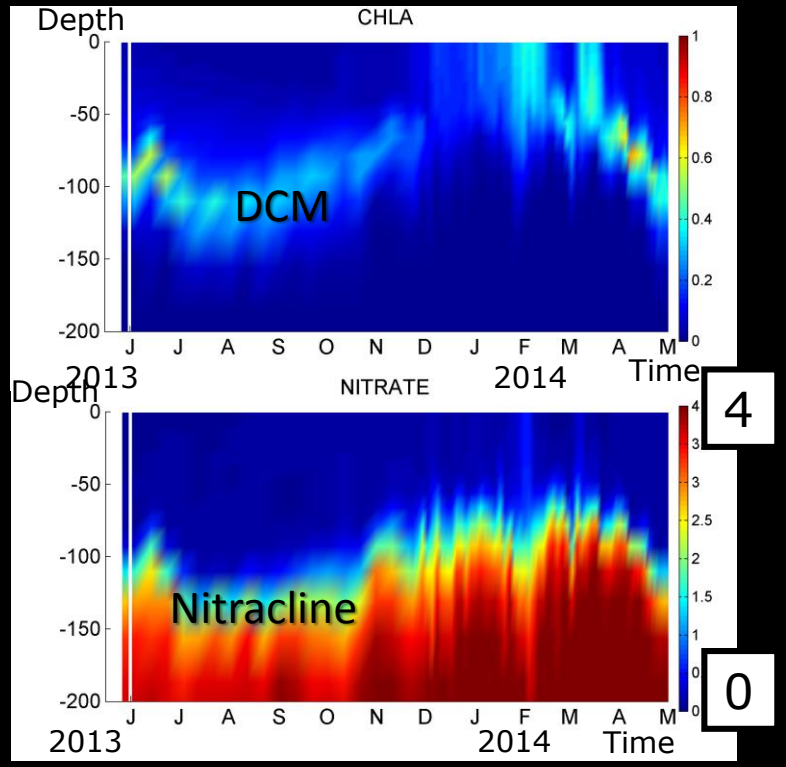


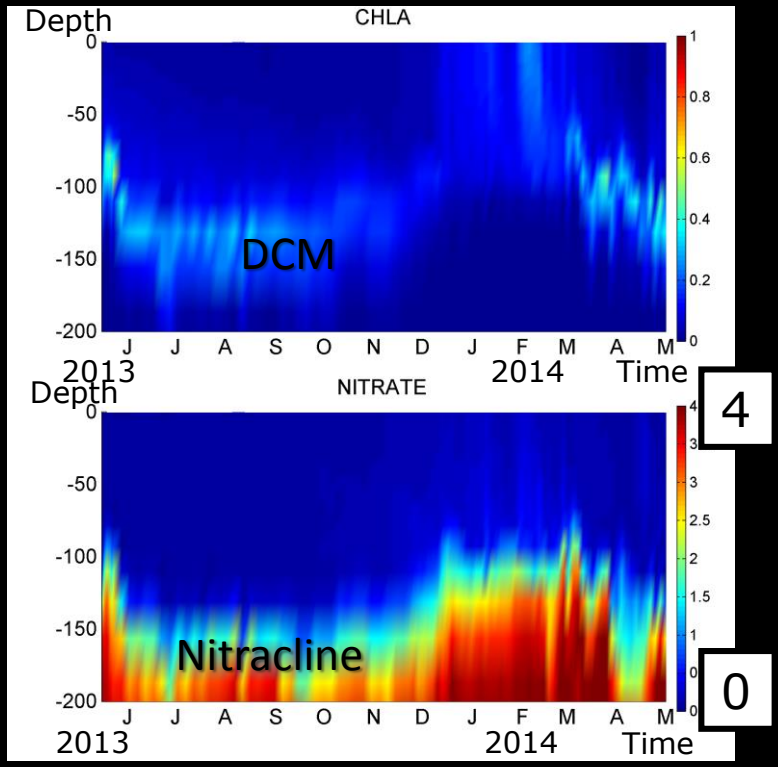




MODEL



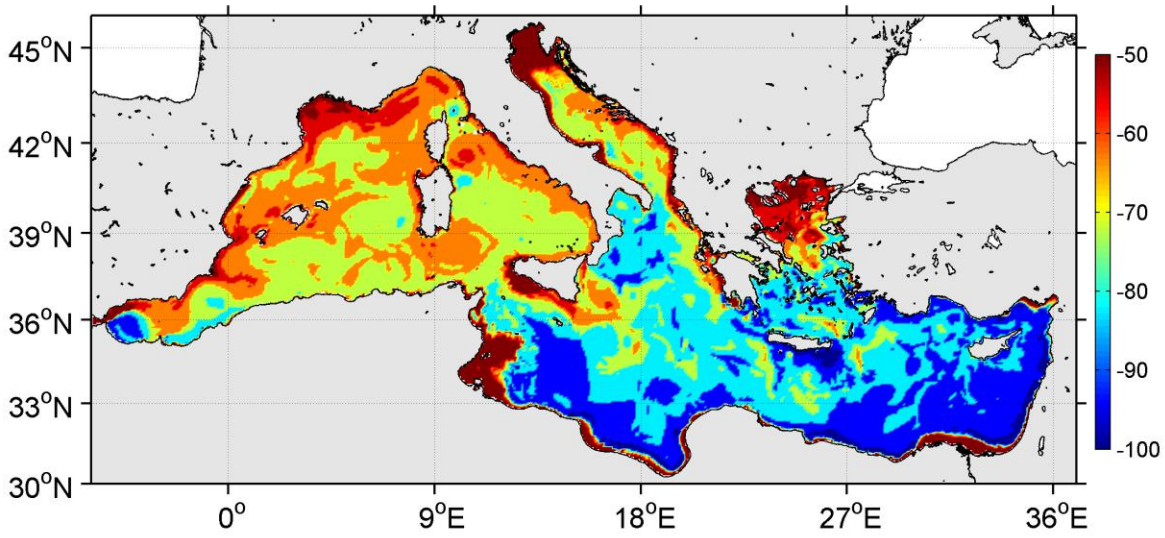




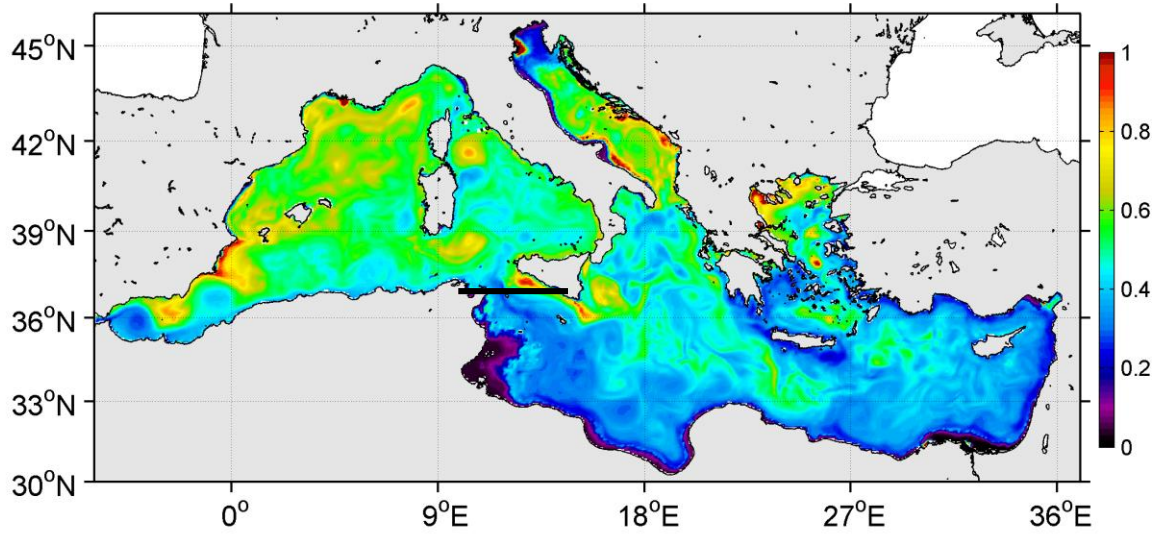
SUMMER

	WEST	EAST
Mean CHL in the DCM	0.52 µg/l	0.38 µg/l
Total contribution of the DCM for the primary production of the basin	41 %	59 %

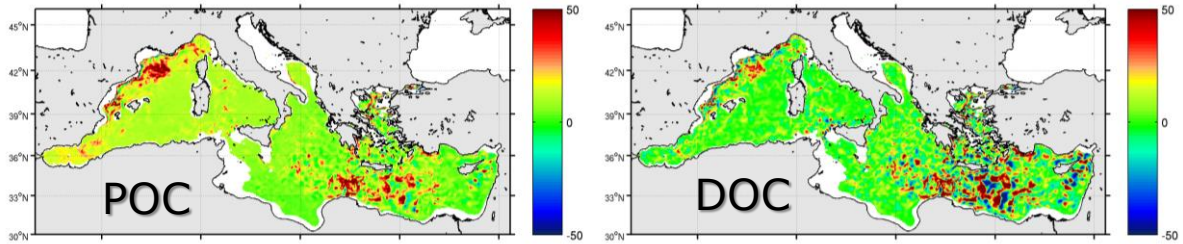
Depth of the Deep Chlorophyll Max



Deep Chlorophyll Max Values



Role for the Carbon export and remineralisation



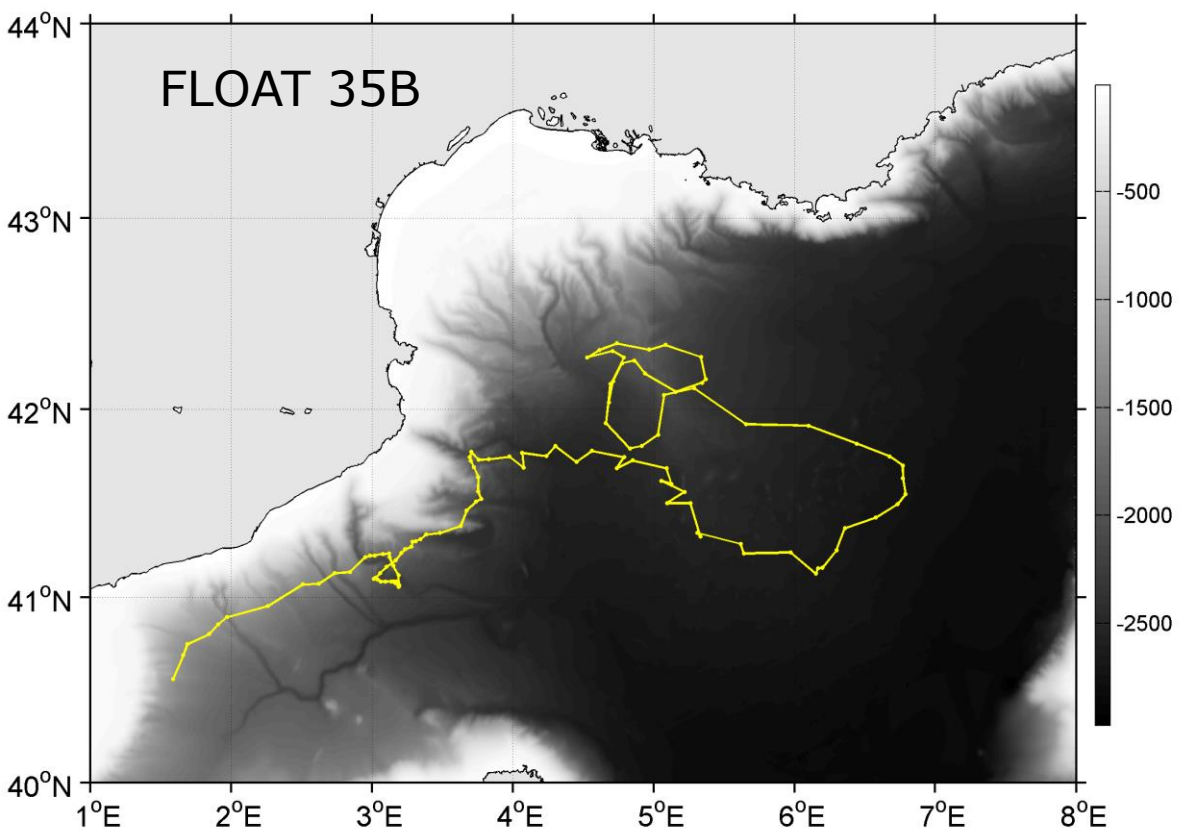
Organic Matter

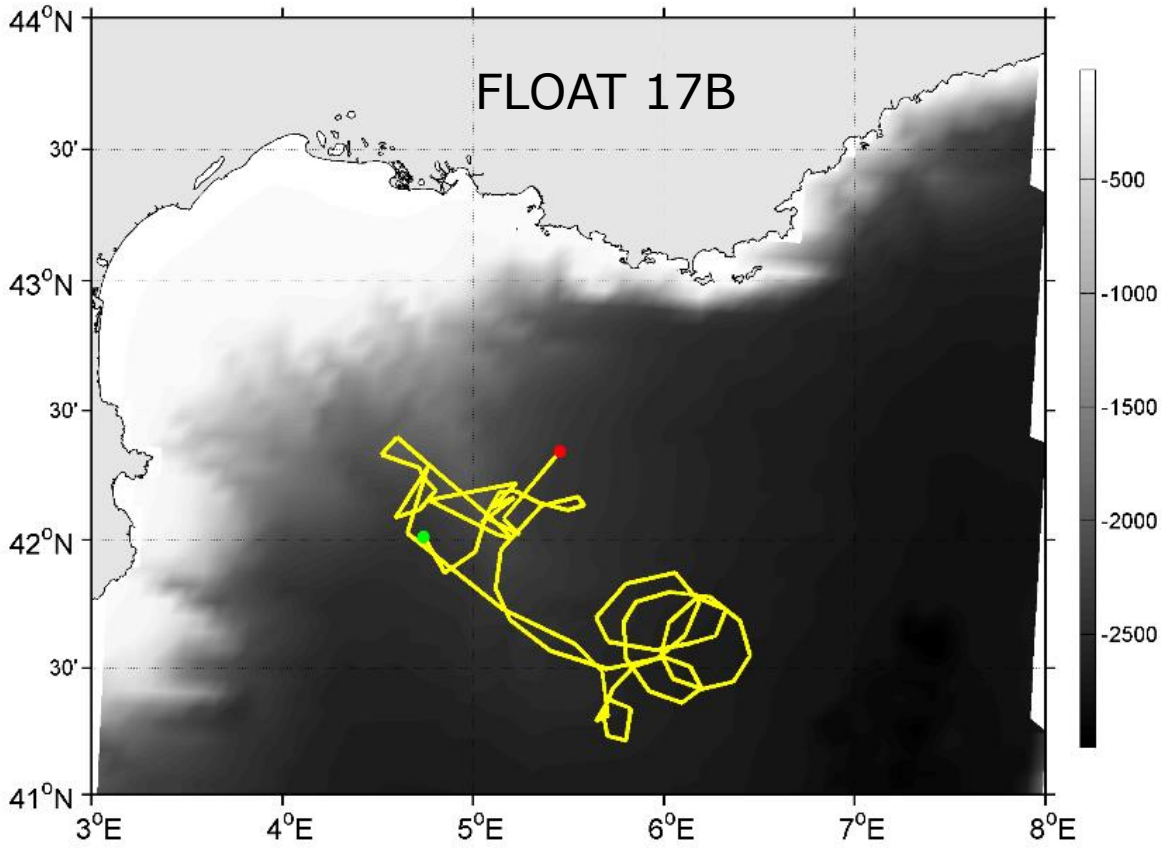
Balance

Inorganic Matter

PART 2

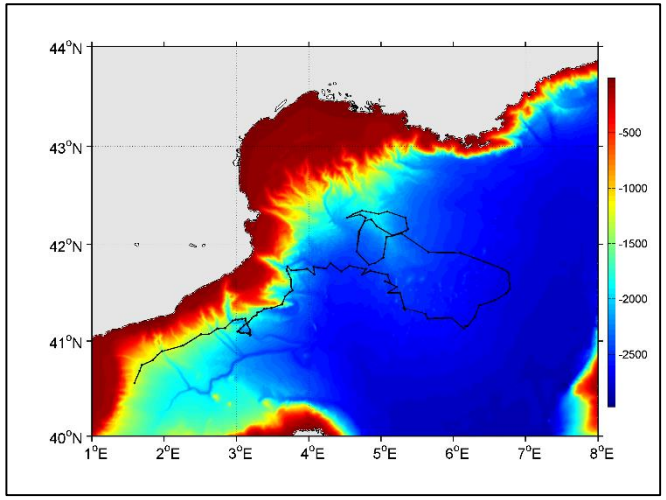
North-Western
Mesoscale processes

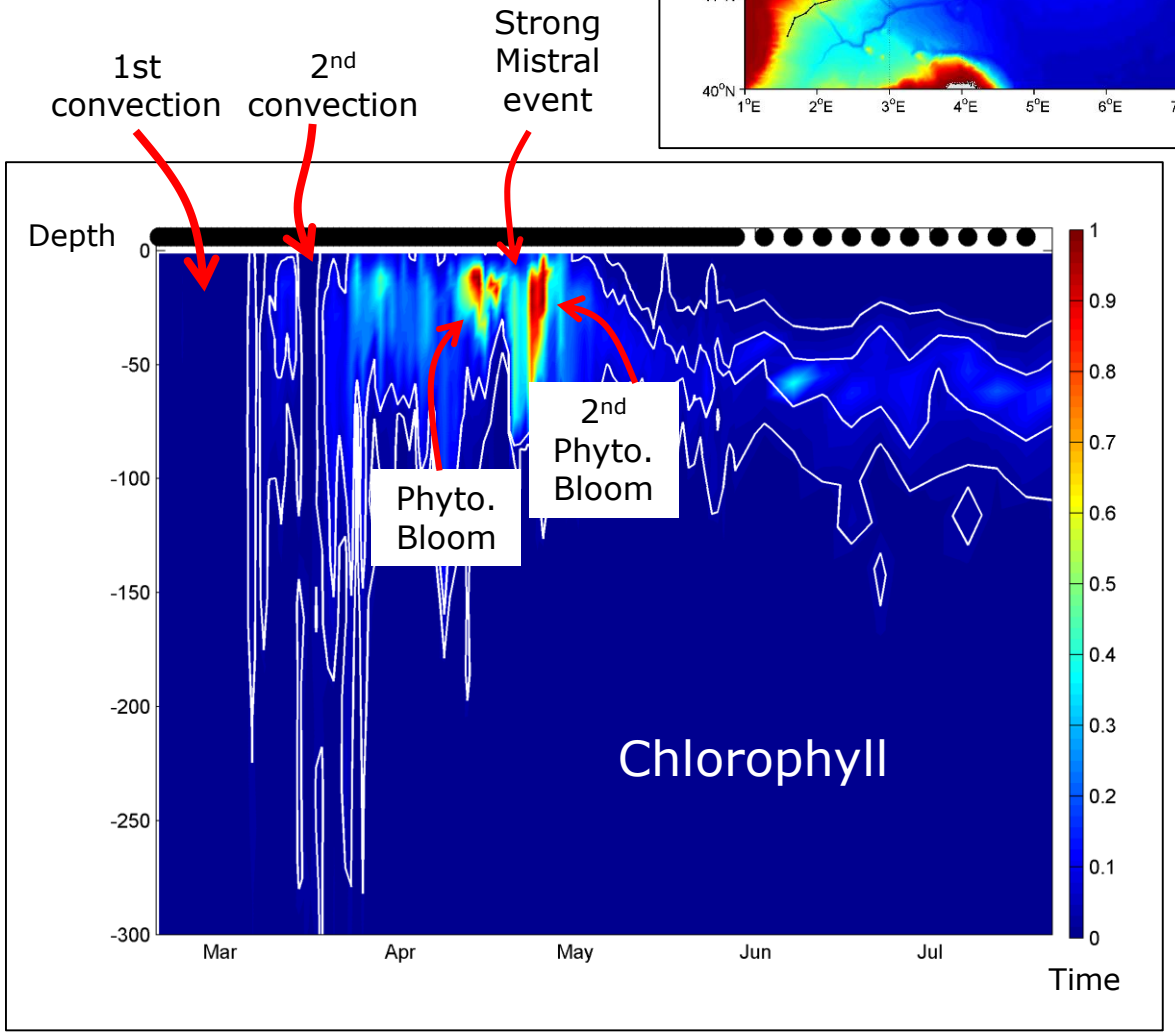


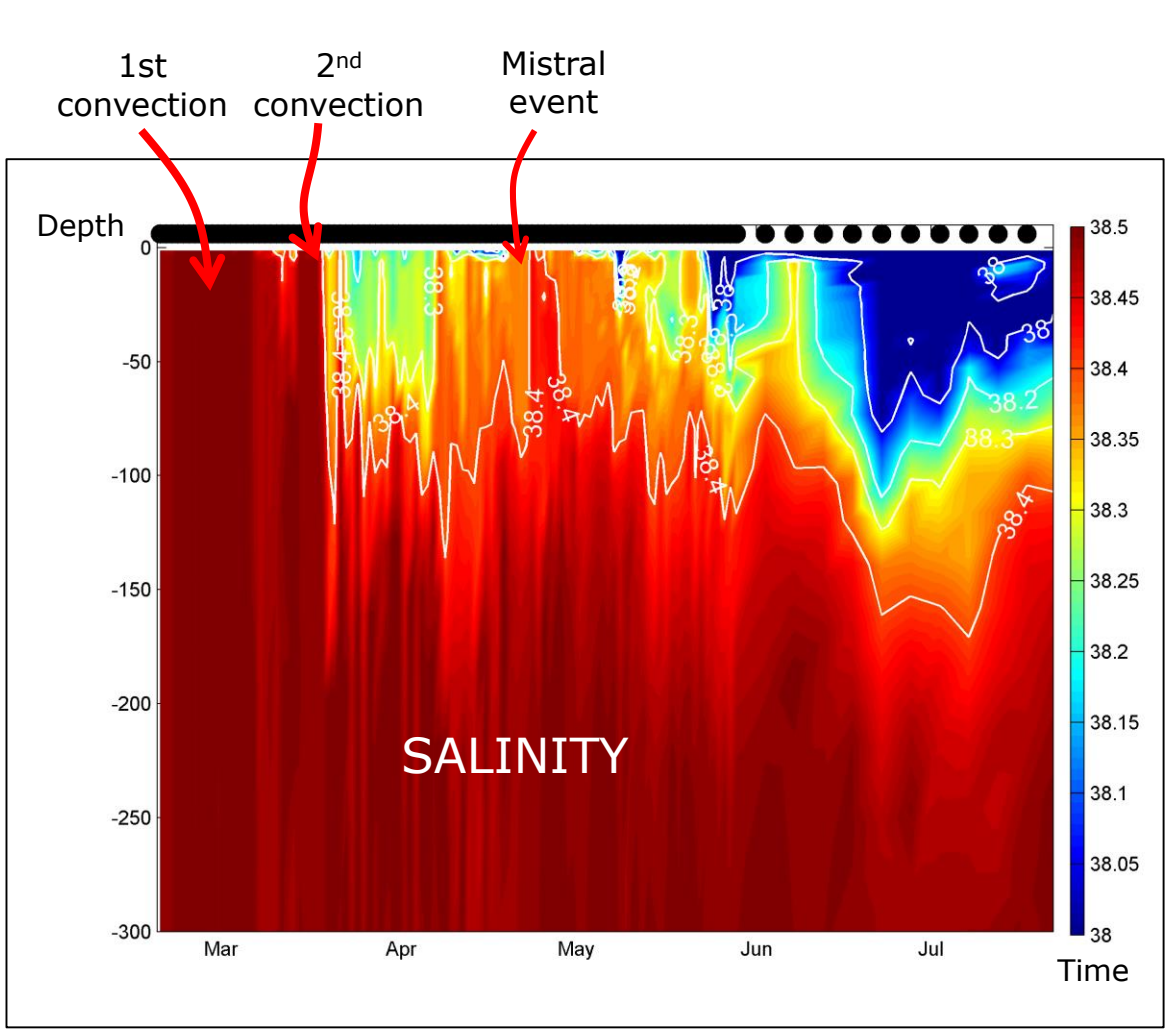


Events experienced by the floats

FLOAT 35B

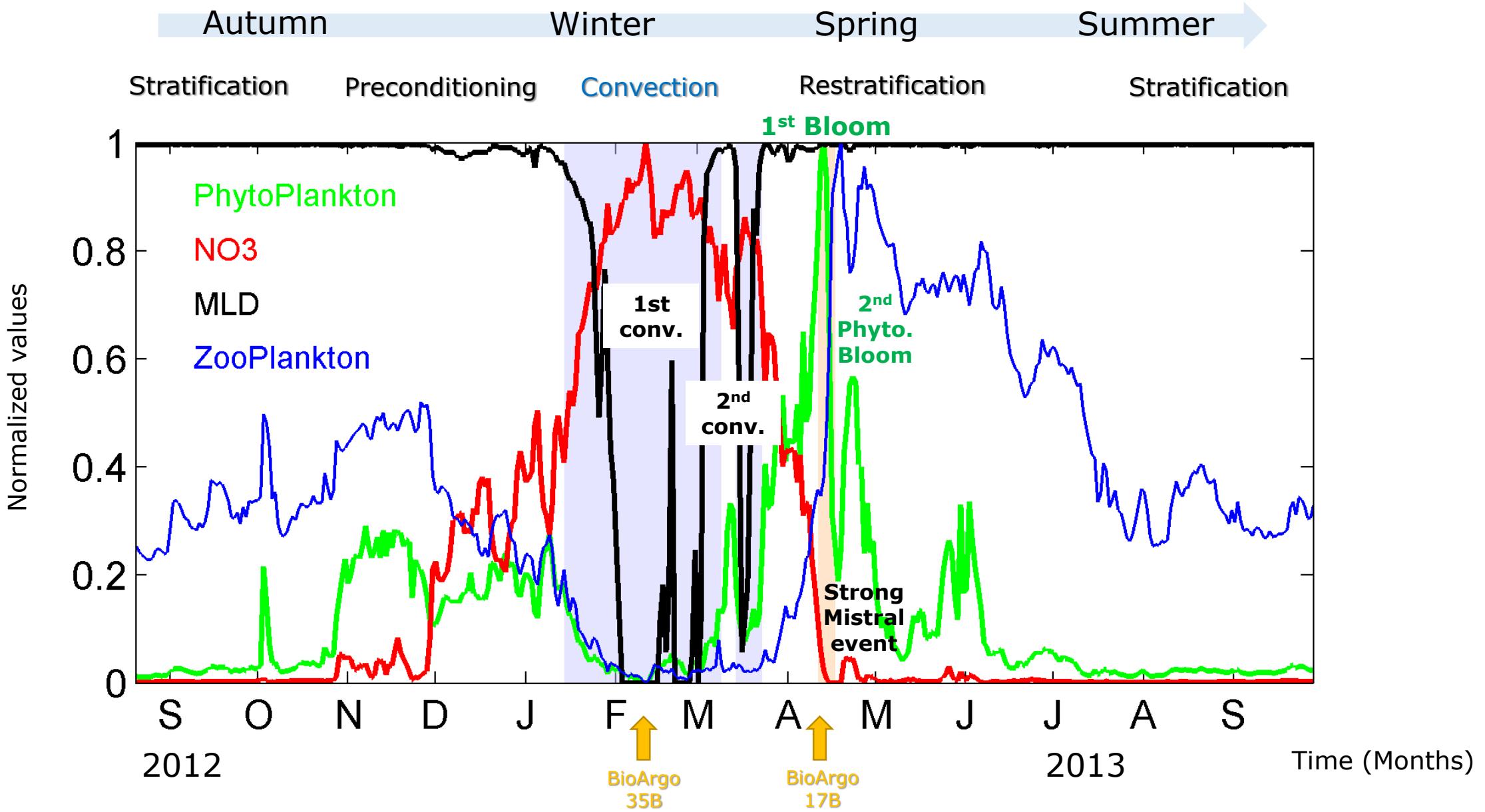

44°N
43°N
42°N
41°N
40°N
1°E
2°E
3°E
4°E
5°E
6°E
7°E
8°E
-500
-1000
-1500
-2000
-2500

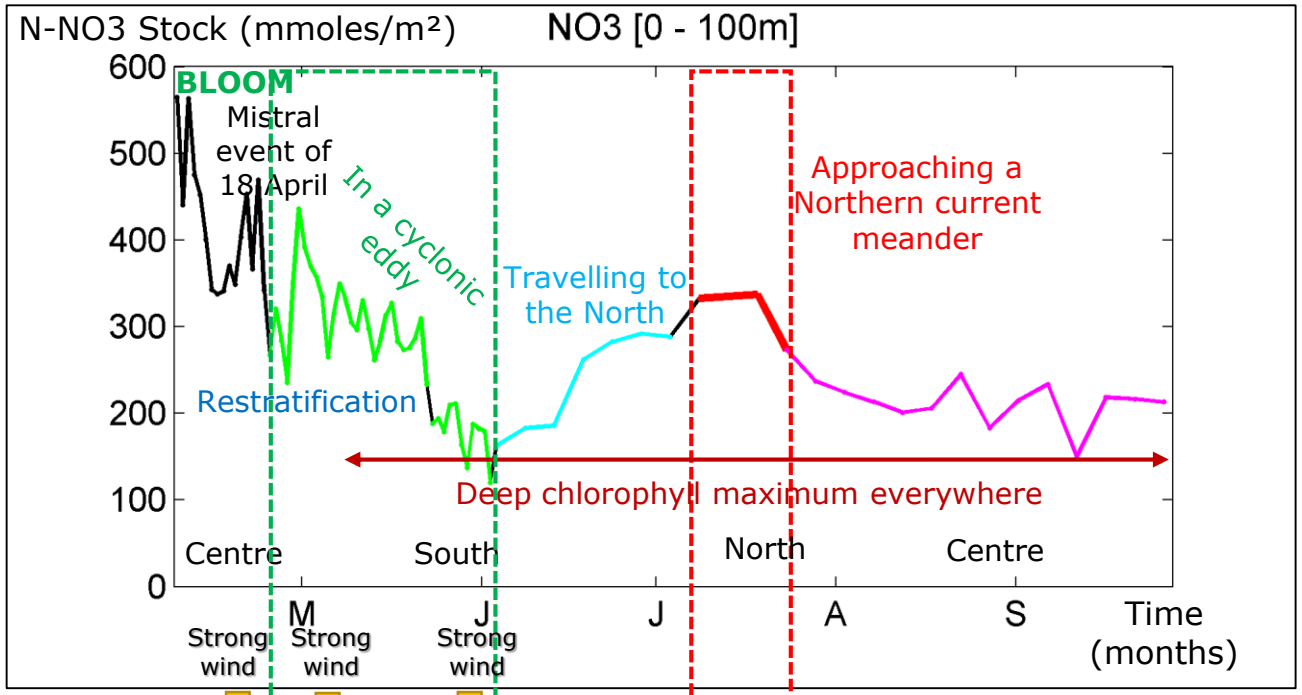

1st convection
2nd convection
Strong Mistral event
Depth
0
-50
-100
-150
-200
-250
-300
Phyto. Bloom
2nd Phyto. Bloom
Chlorophyll
Mar
Apr
May
Jun
Jul
Time
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

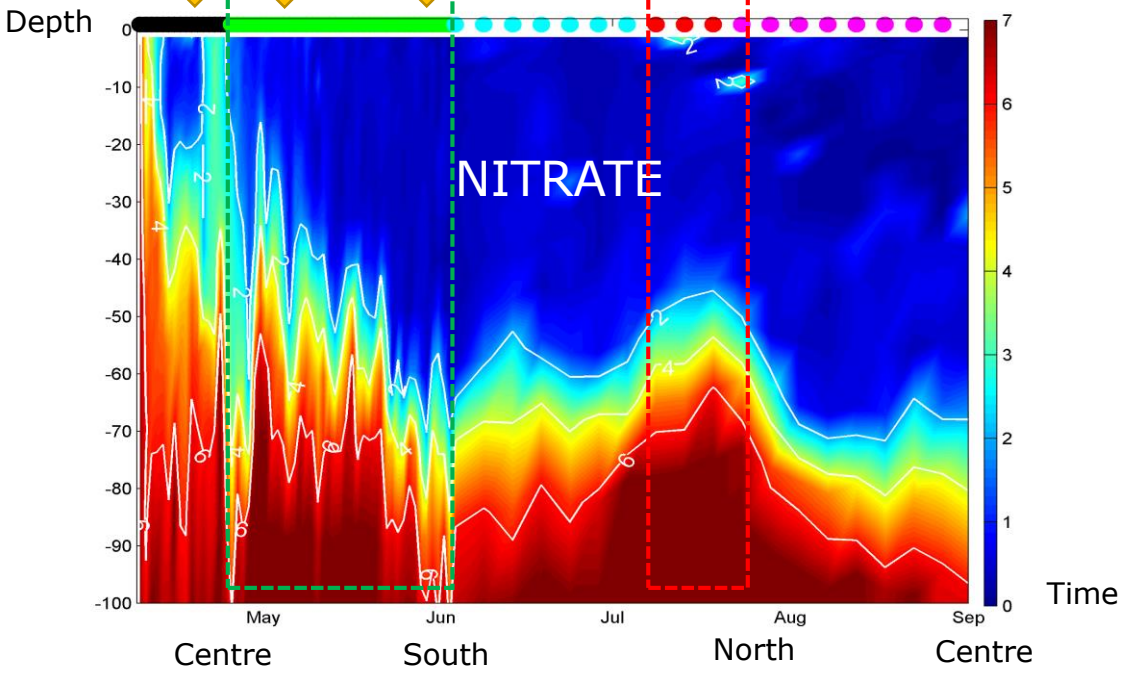

1st convection
2nd convection
Mistral event
Depth
0
-50
-100
-150
-200
-250
-300
SALINITY
Mar
Apr
May
Jun
Jul
Time
38.5
38.45
38.4
38.35
38.3
38.25
38.2
38.15
38.1
38.05
38

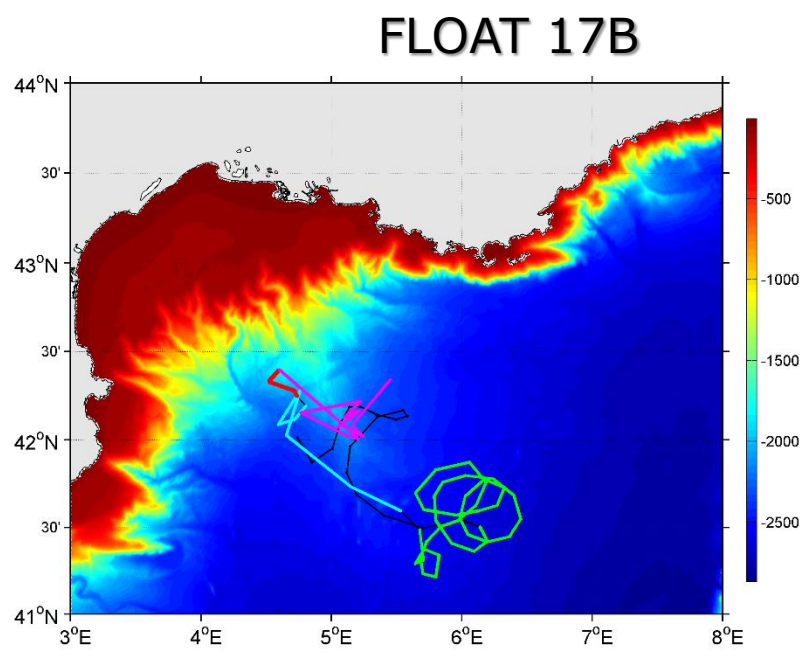
MODEL

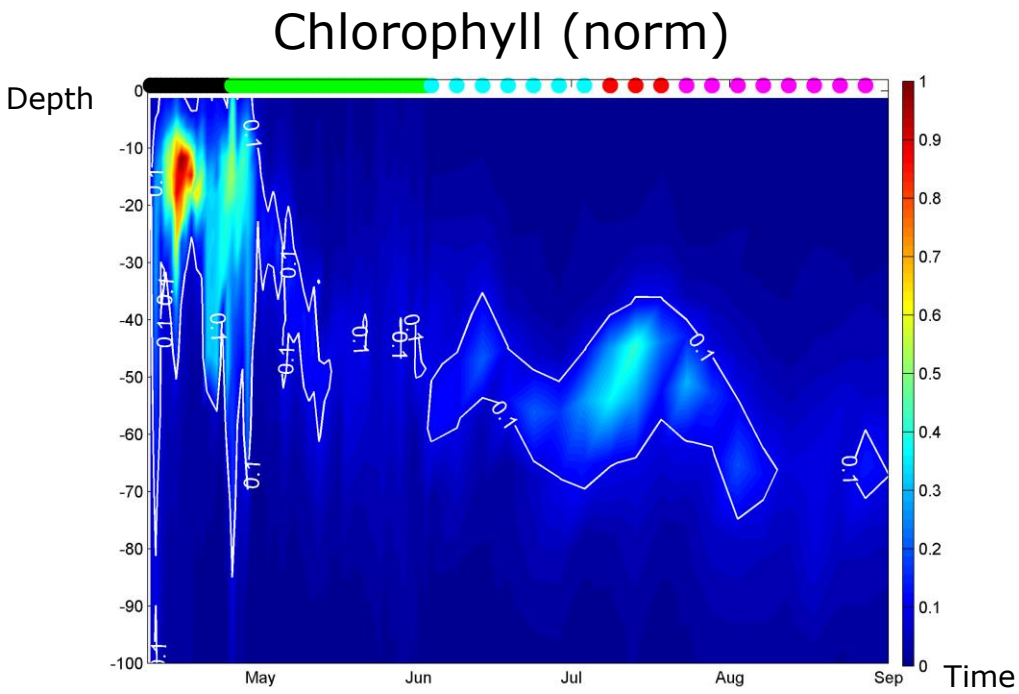
North western Mediterranean annual analysis (surface evolution)




N-NO3 Stock (mmoles/m²)
NO3 [0 - 100m]
BLOOM
Mistral event of 18 April
In a cyclonic eddy
Restratification
Travelling to the North
Approaching a Northern current meander
Deep chlorophyll maximum everywhere
Centre
South
North
Centre
Strong wind
Strong wind
Strong wind
Time (months)


Depth
NITRATE
May
Jun
Jul
Aug
Sep
Time
Centre
South
North
Centre


FLOAT 17B


Chlorophyll (norm)
Depth
May
Jun
Jul
Aug
Sep
Time

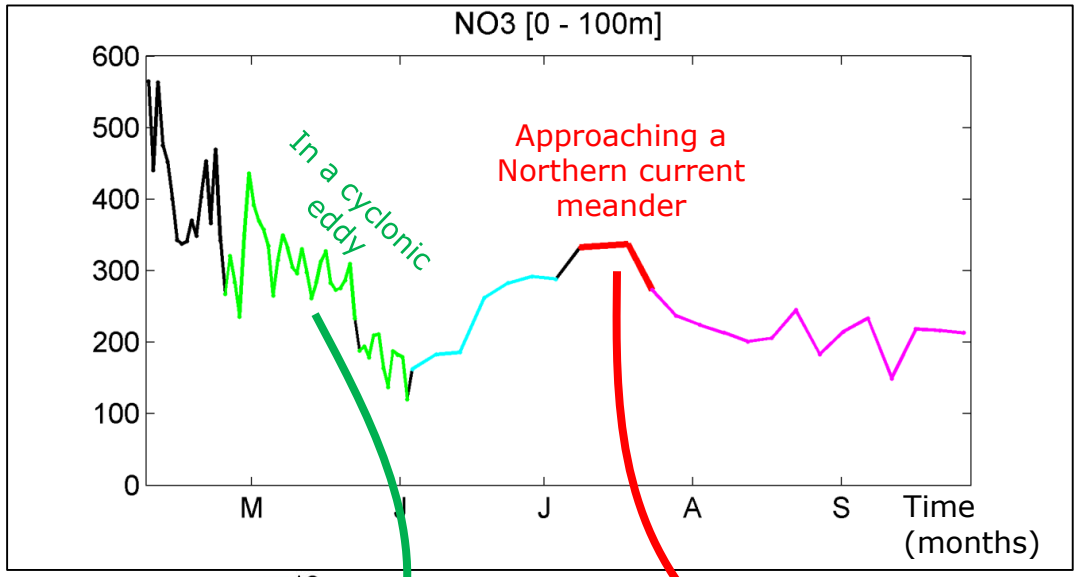
FLOAT 17B

In a cyclonic eddy

Assumptions:

Decreasing of nutrients caused by the restratification

Oscillations caused by Mistral wind serval events

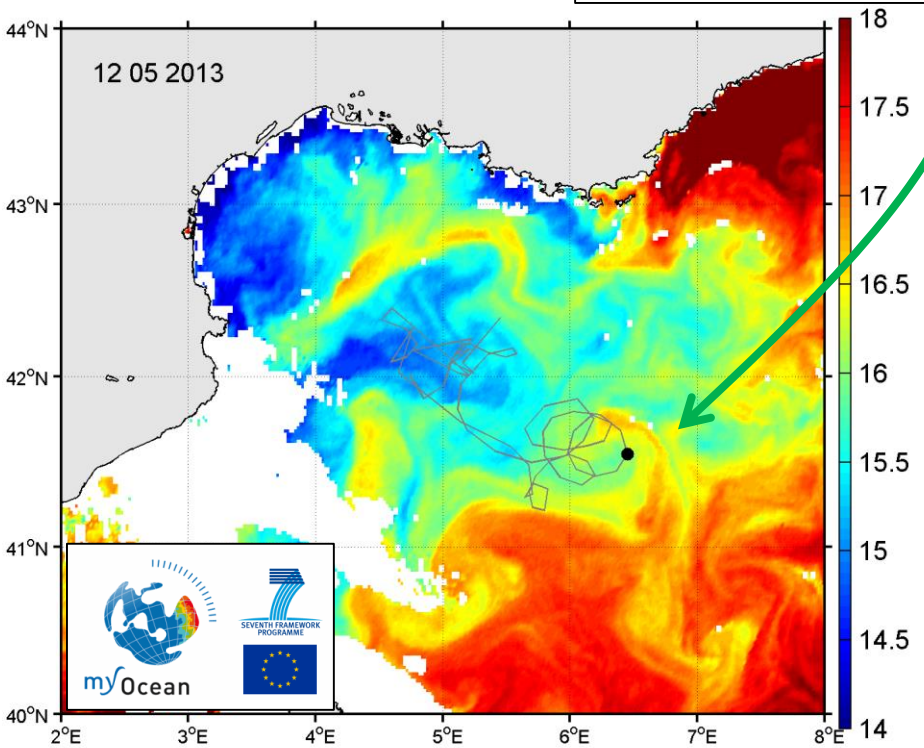


Approaching a Northern current meander

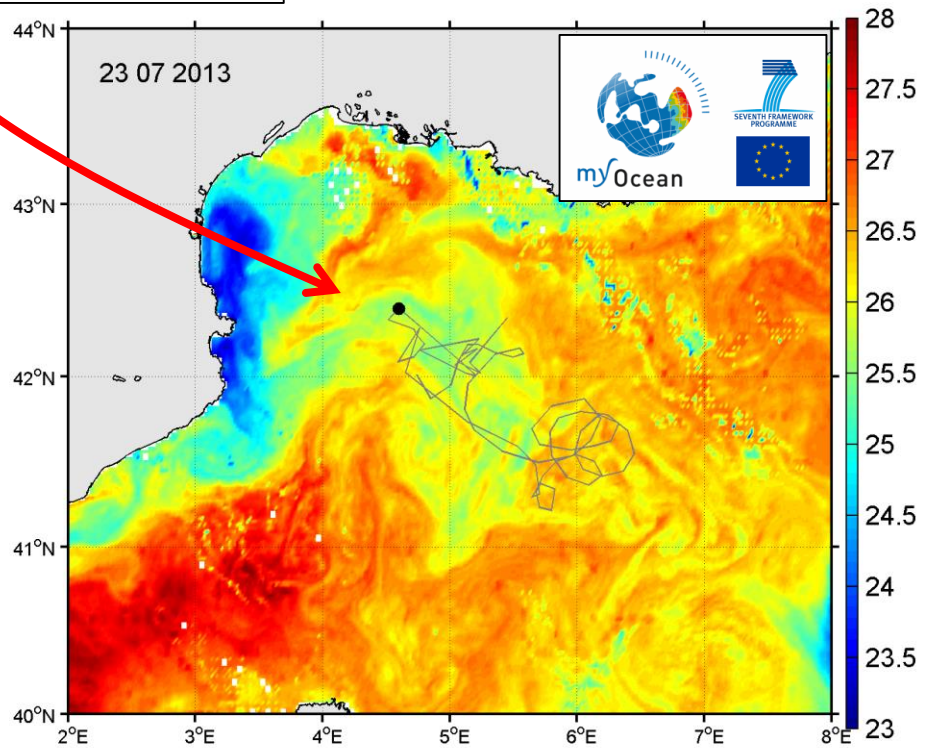
Assumption:

Increasing of nutrients caused by a front vertical advection

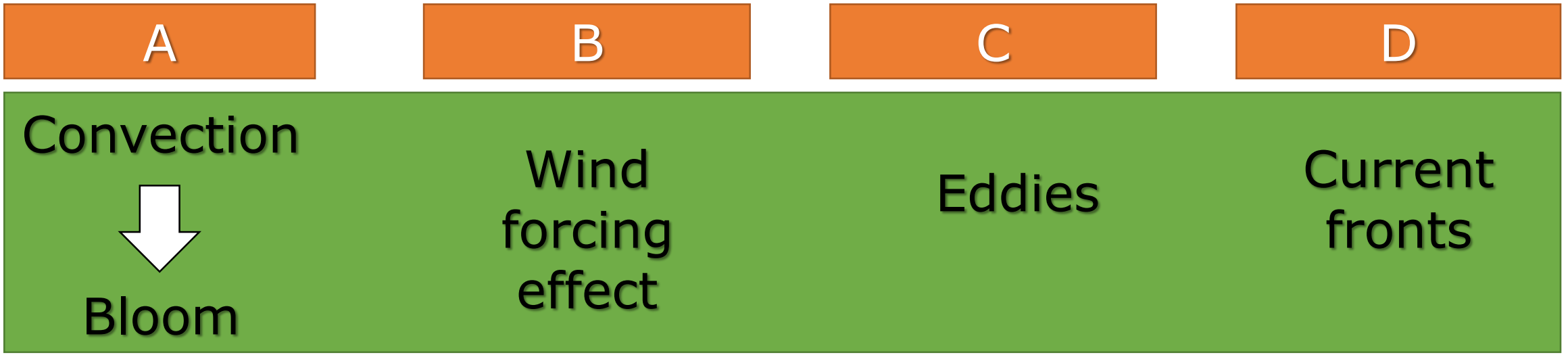
SST (°C)



SST (°C)



Physical events produced in the model between April and September with the ability to impact the biological system

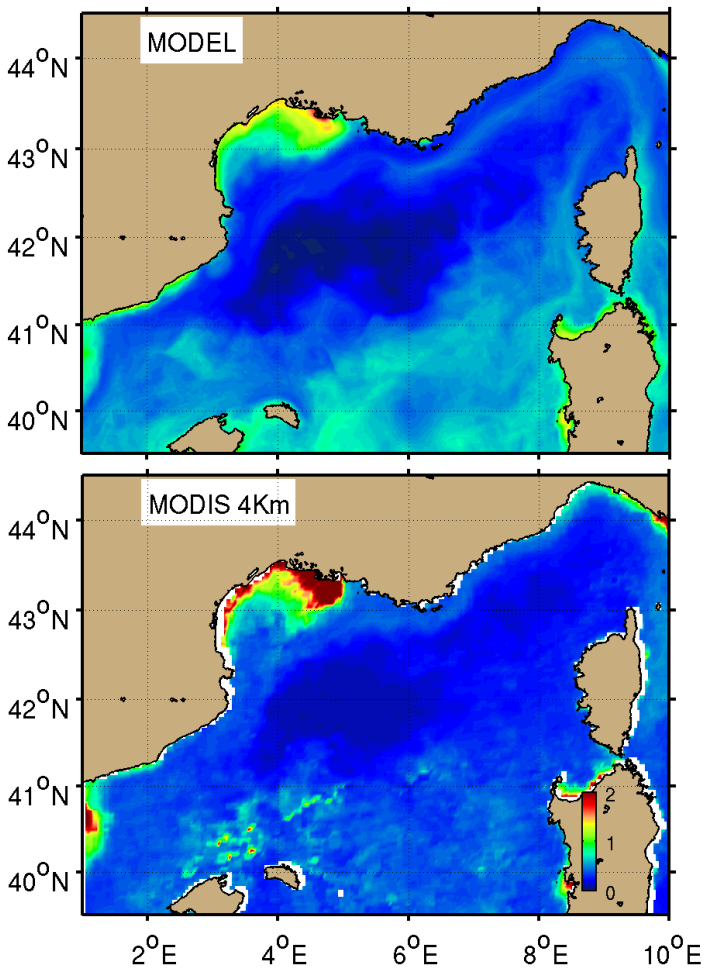


A

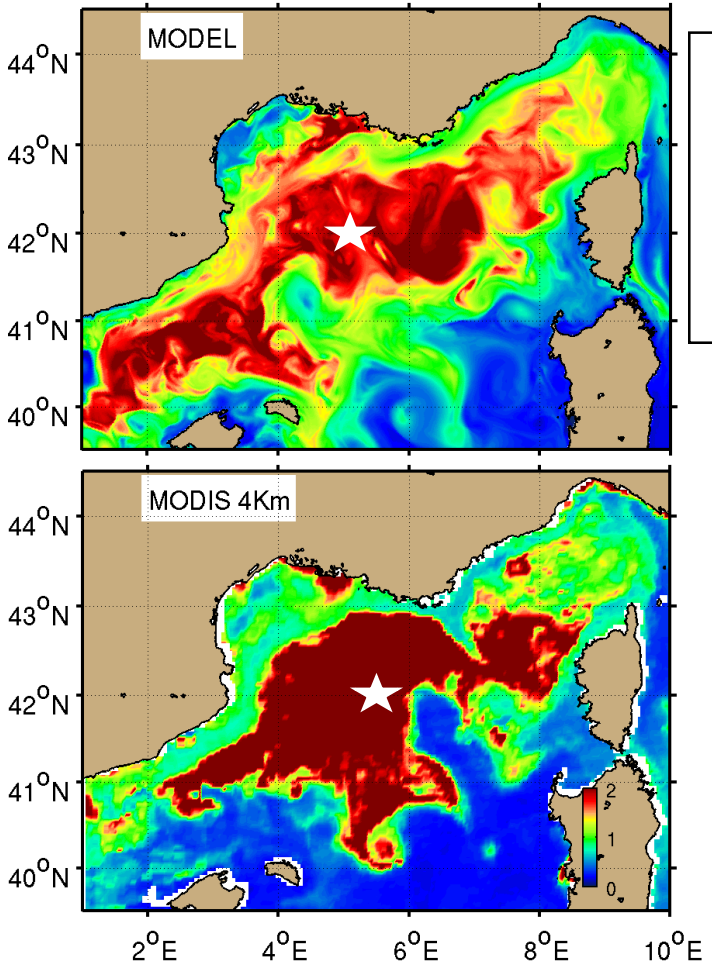
Phyto Bloom

9-17 April 2013

Convection February 2013

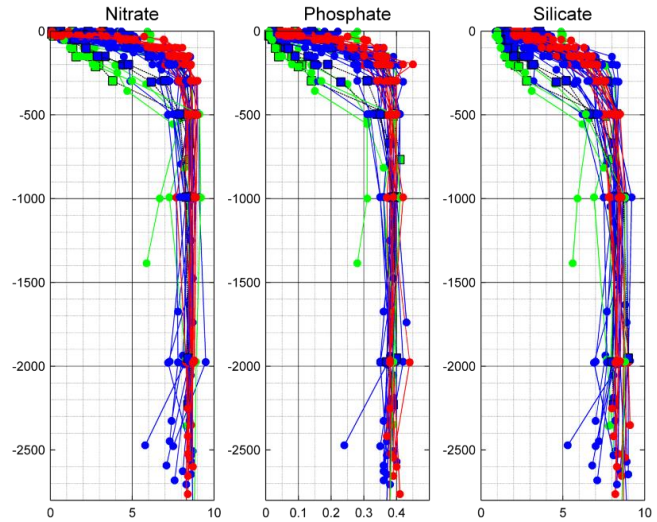


Bloom April 2013



Red profiles: Shallow nitracline < 50 m INSIDE THE BLOOM AREA

Green profiles: Deep nitracline ~ 80-90 m OUTSIDE THE BLOOM AREA



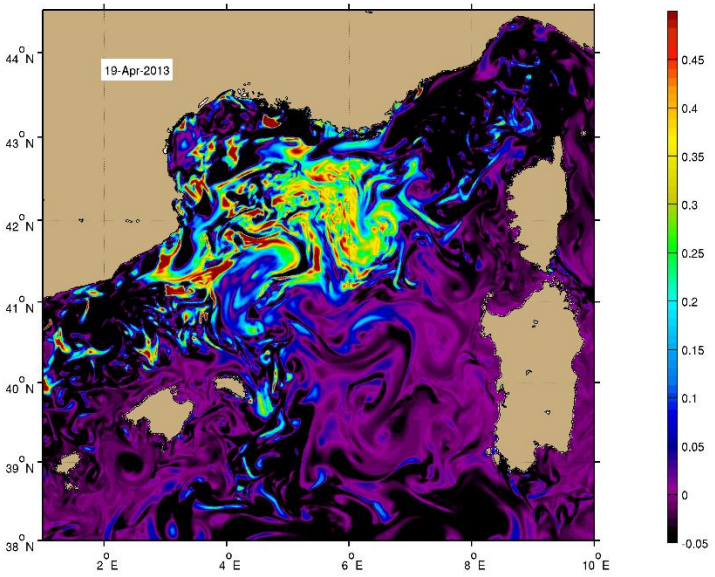
The "lovbio 17B" float was deployed under these conditions

B

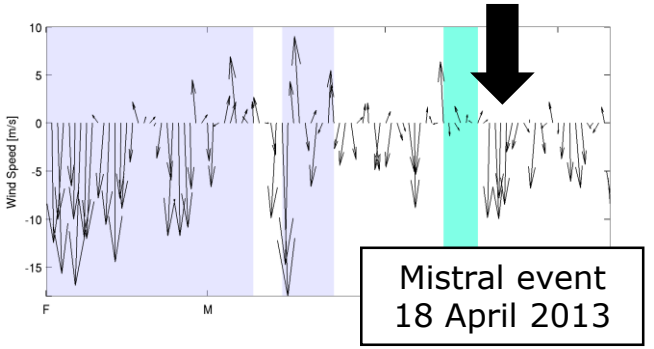
Mistral Wind forcing

18 April 2013

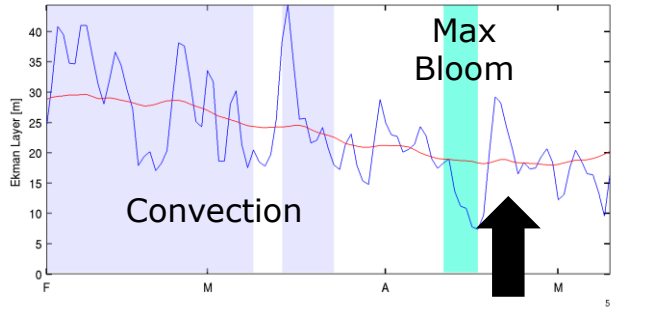
Surface Chla rate of change in April from 18 to 19th (µg/l/d)



Wind speed and direction (m/s)

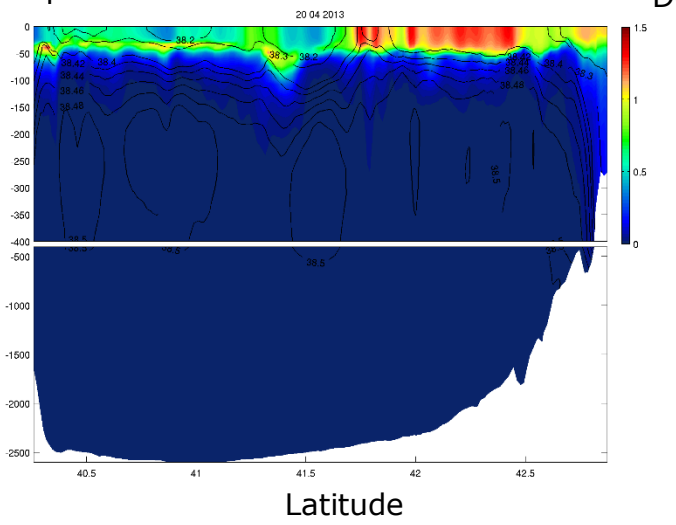


Ekman Layer (m)

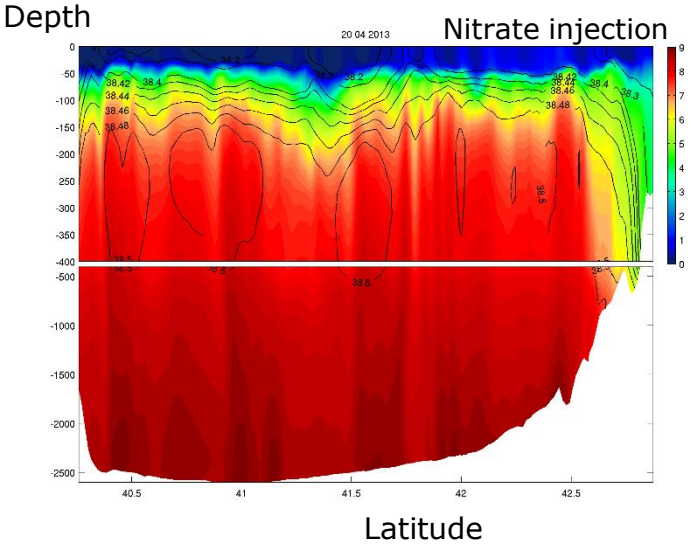


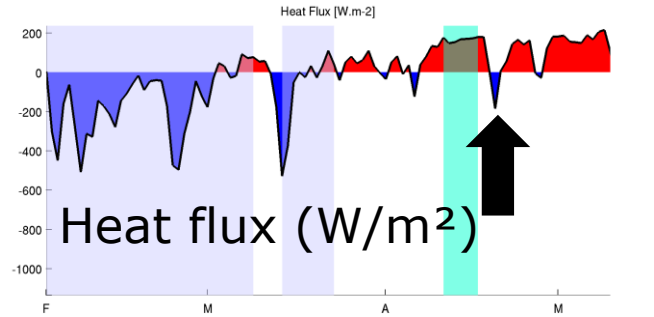
Deepening of the Ekman layer by 25m in 1 day

Chla across the 2nd bloom (µg/l)



Nitrate across the 2nd bloom (µg/l)



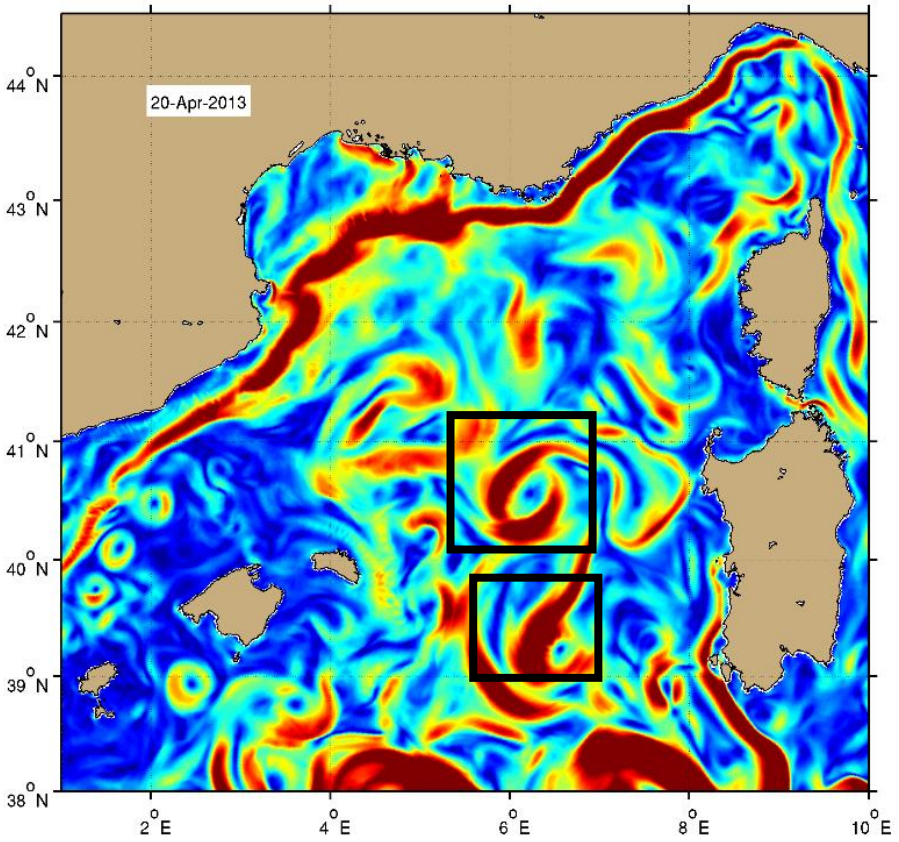


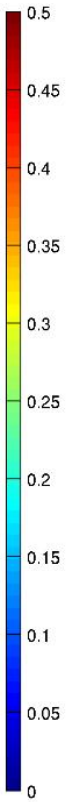
400 w/m2 lost in 1 day

C

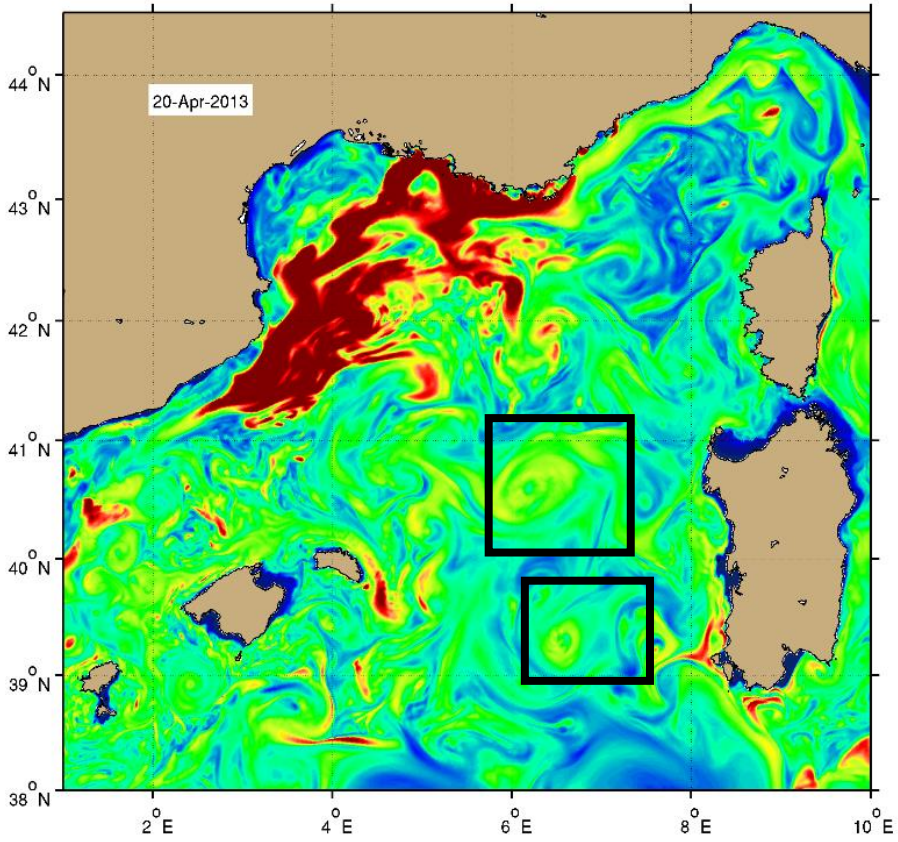
Cyclonic eddies

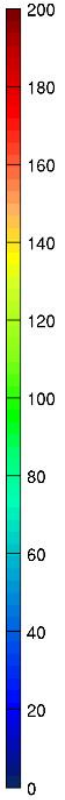
Surface velocity (m/s)





Nitrate uptake by Phytoplankton (mmol N/m²/d)

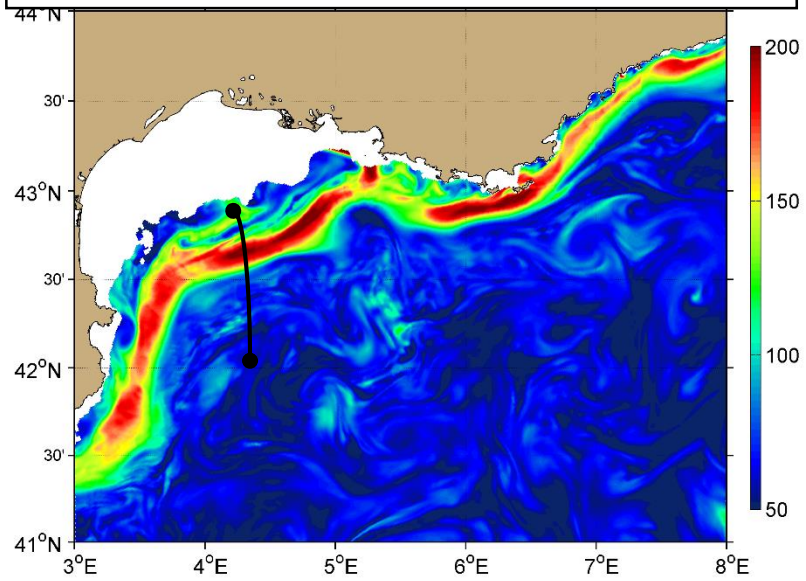




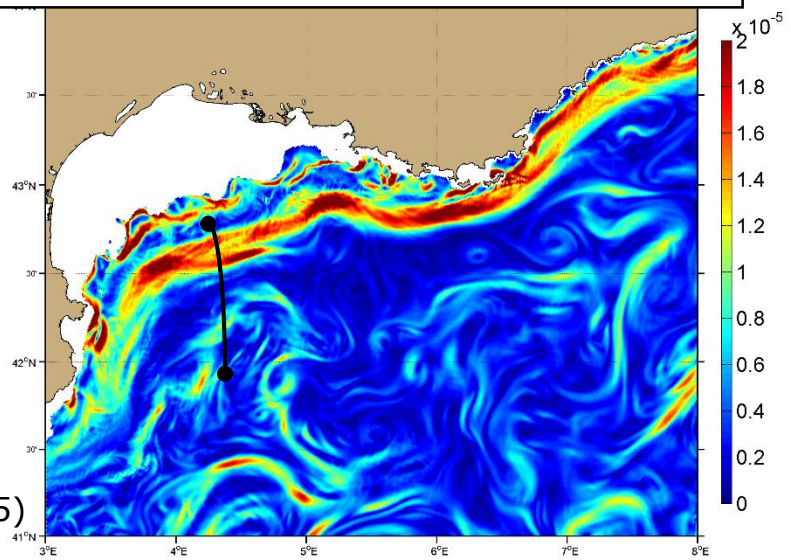
D

Northern current front

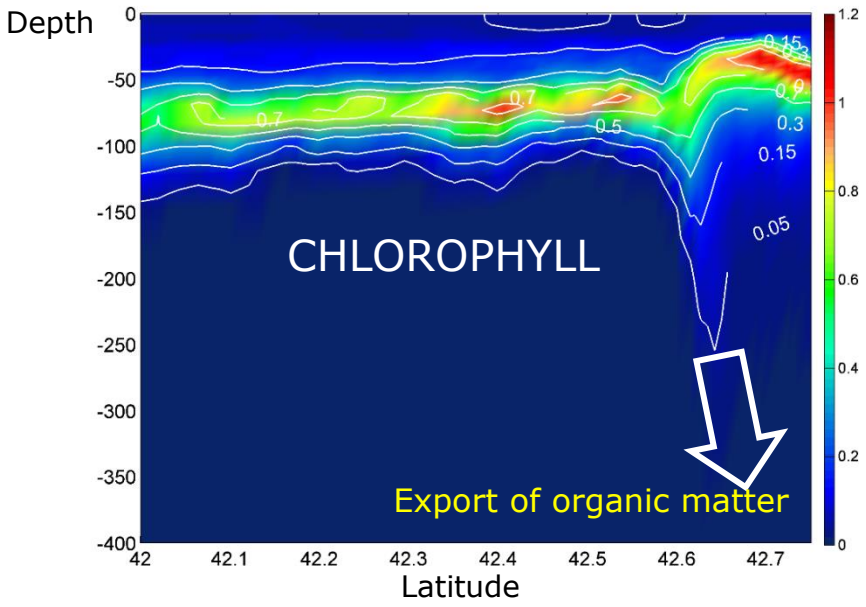
Nitrate uptake by Phytoplankton (mmol N/m²/d)

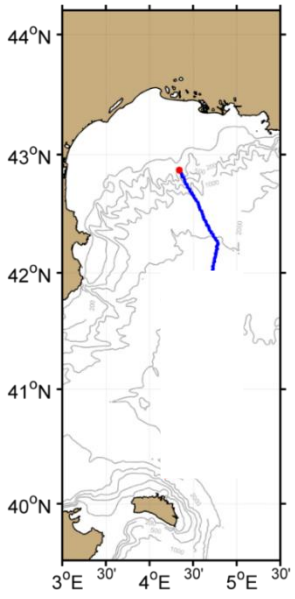


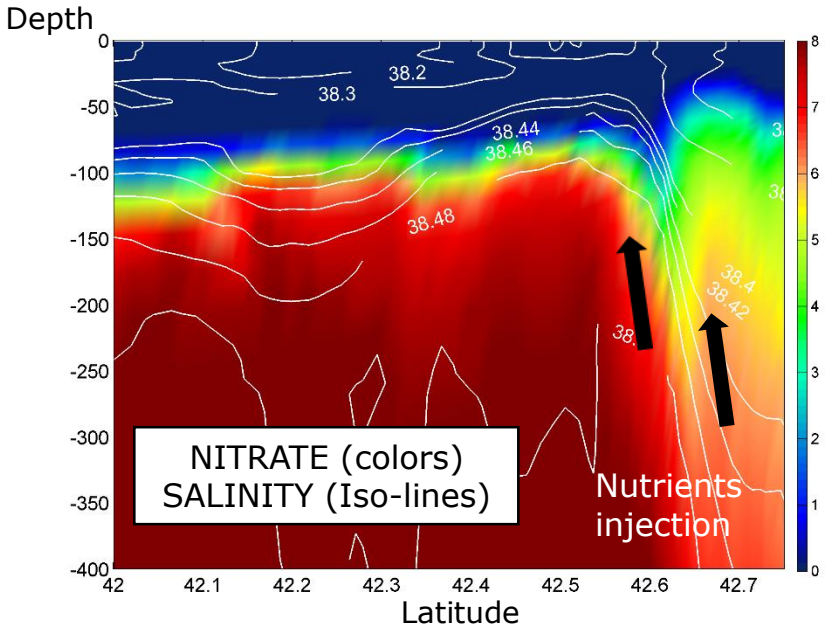
Density gradient at 100m depth



Front strength depends also on wind forcing (Goffart et al 1995)







Conclusions

Importance of the BioArgo floats

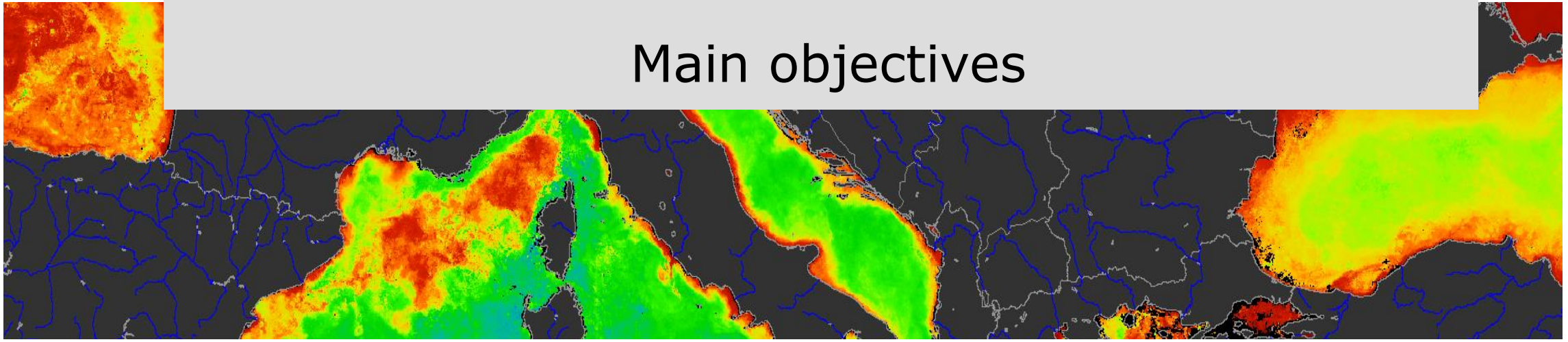
- Validation of the models thanks to the spatial and temporal aspects of the measurements

- Coupled work between models and floats for better understanding :

1. Mesoscale processes
2. Temporary events
3. Extreme events
4. Seasonal cycles in Mediterranean bioregions

- Model + floats + cruises sampling represent an integrated survey of a large zones systems

Main objectives



1. Quantifying of the primary production and the deep export of dissolved and particulate carbon

2. Global biogeochemical functioning of the Mediterranean Sea

Results will be presented at the **EGU Conference in Vienna (Austria) starting from April 12th 2015**

Session 1: **OS2.2**
2 Posters:

- The CO2 system in the Mediterranean Sea (Ulses et al)
- Mediterranean organic and nutrients budget (Kessouri et al)

Session 2: **OS3.1**
1 Poster :

- North Western winter and spring mesoscale analysis from modelling and MerMex-Dewex experiments (Kessouri et al)

Thank you

Acknowledgment to Jonathan Beuvier (Mercator Ocean)