A 4D mesoscale map of the spring bloom during the POMME experiment Results of a prognostic model

M. Levy (LODYC) , M. Gavart (SHOM), L. Memery (LEMAR),
G. Caniaux and A. Paci (CNRM)

POMME: Program Ocean Multidisciplinary MEsoscale

Objectives

Role of mesoscale eddies on :

•Subduction of subpolar mode water

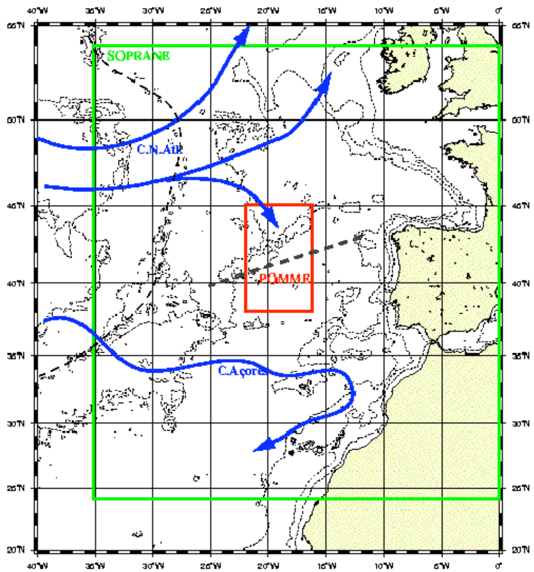
•Their biogeochemical properties

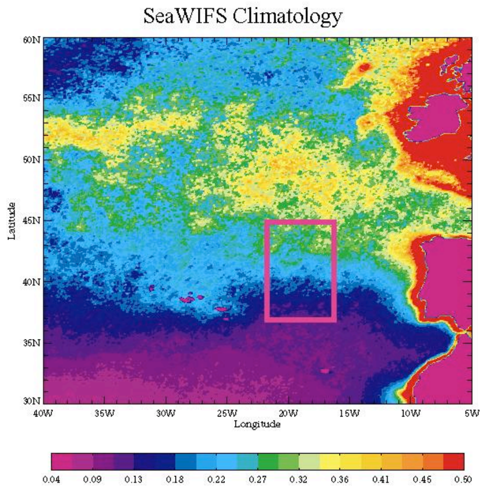
Pomme area

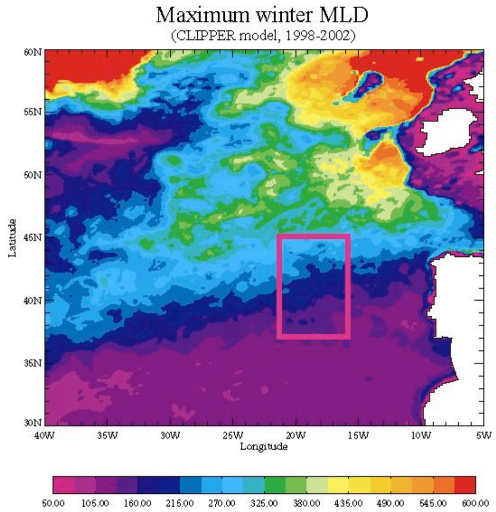
•7 degrees latitude x 5 degrees longitude

•Mixed-layer depth gradient

•Productivity gradient

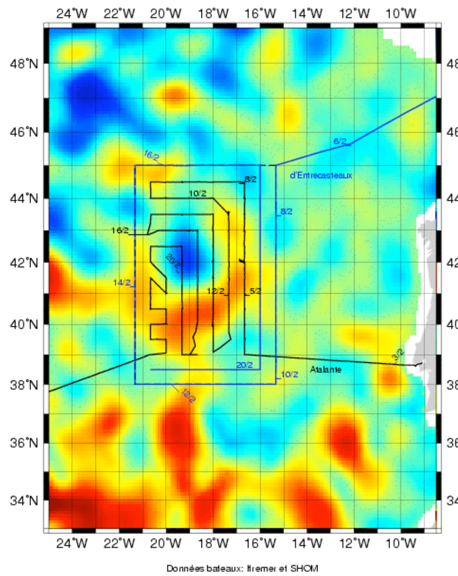




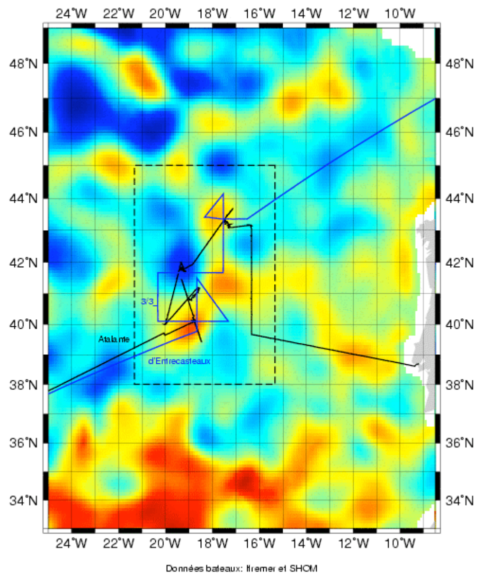


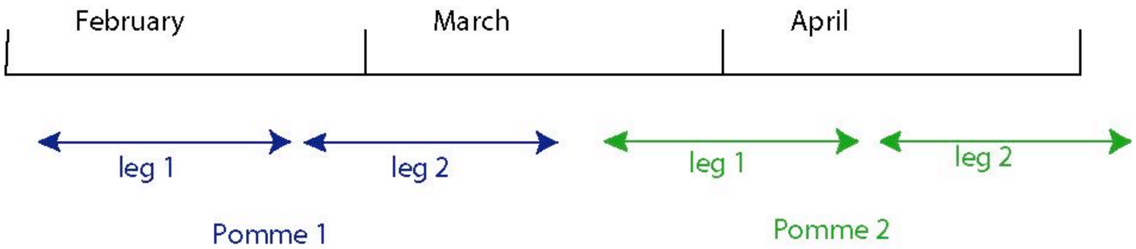
POMME: Observational strategy

Leg1



Leg2





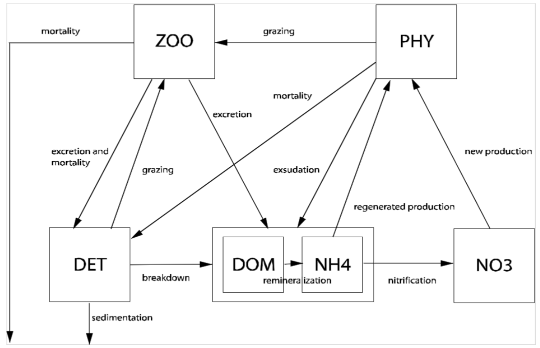
- Winter and Spring : P1, P2
- Floats +SLA : define the mesoscale environment
- Continuous presence at sea during 3 months in 2001
- Legs 1 : mesoscale surveys CTD - 50 km, 3 weeks
- Legs 2 : 4 stations located in specific eddies or at their border were visited intensively for a couple days (longer biological experiments)
- Advantage : both large scale and mesoscale characteristics
- Problems : asynopticity + resolution

POMME: Model study

Objectives

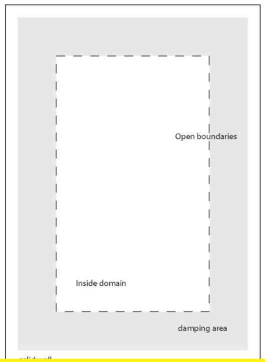
•Give a synoptic view of the area during each cruise
•Analyze the dominant scales of variability

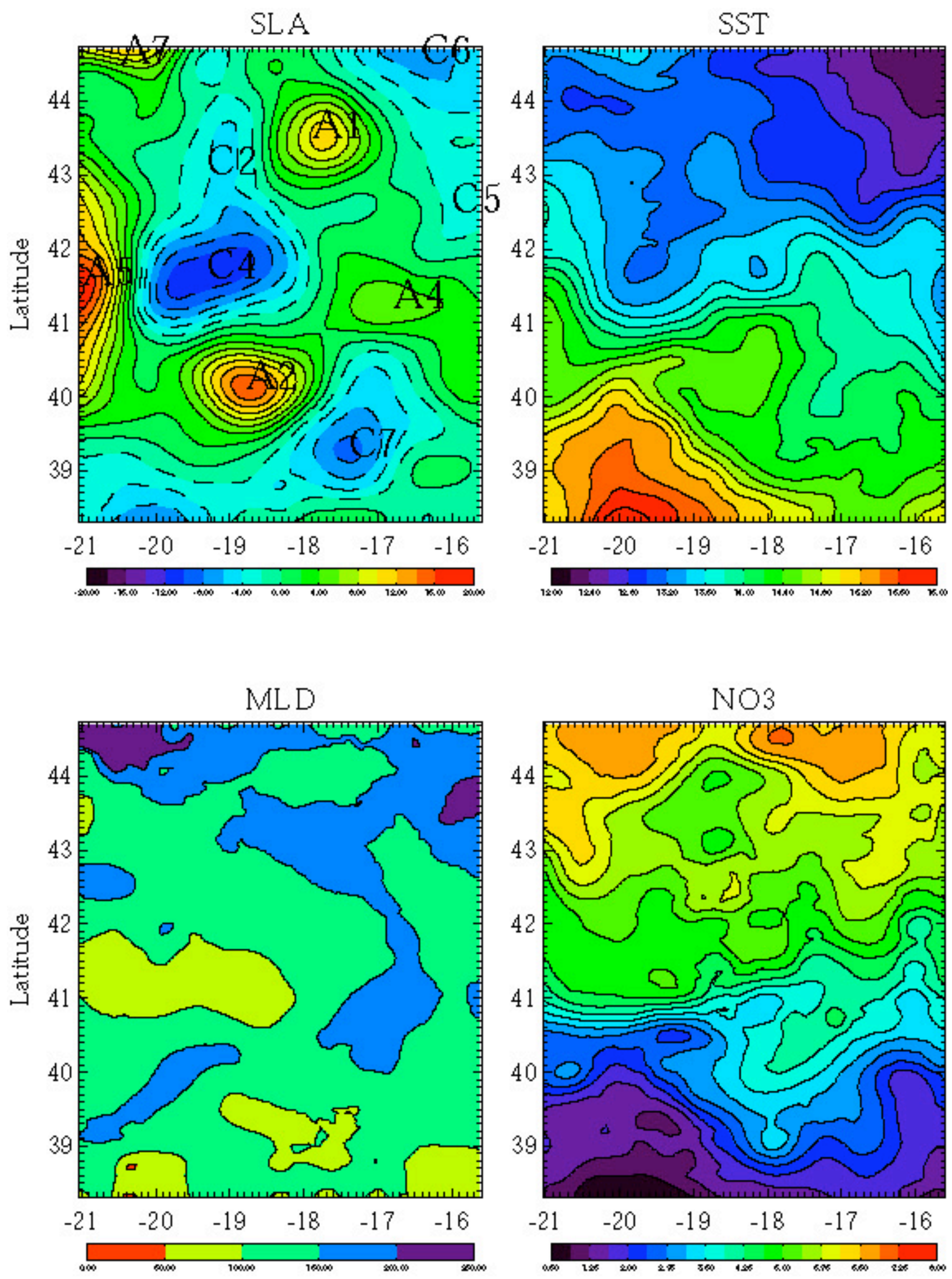
Biogeochemical model



Physical model

•Primitive equations OPA
•5 km resolution
•Open boundaries
•4 months simulation

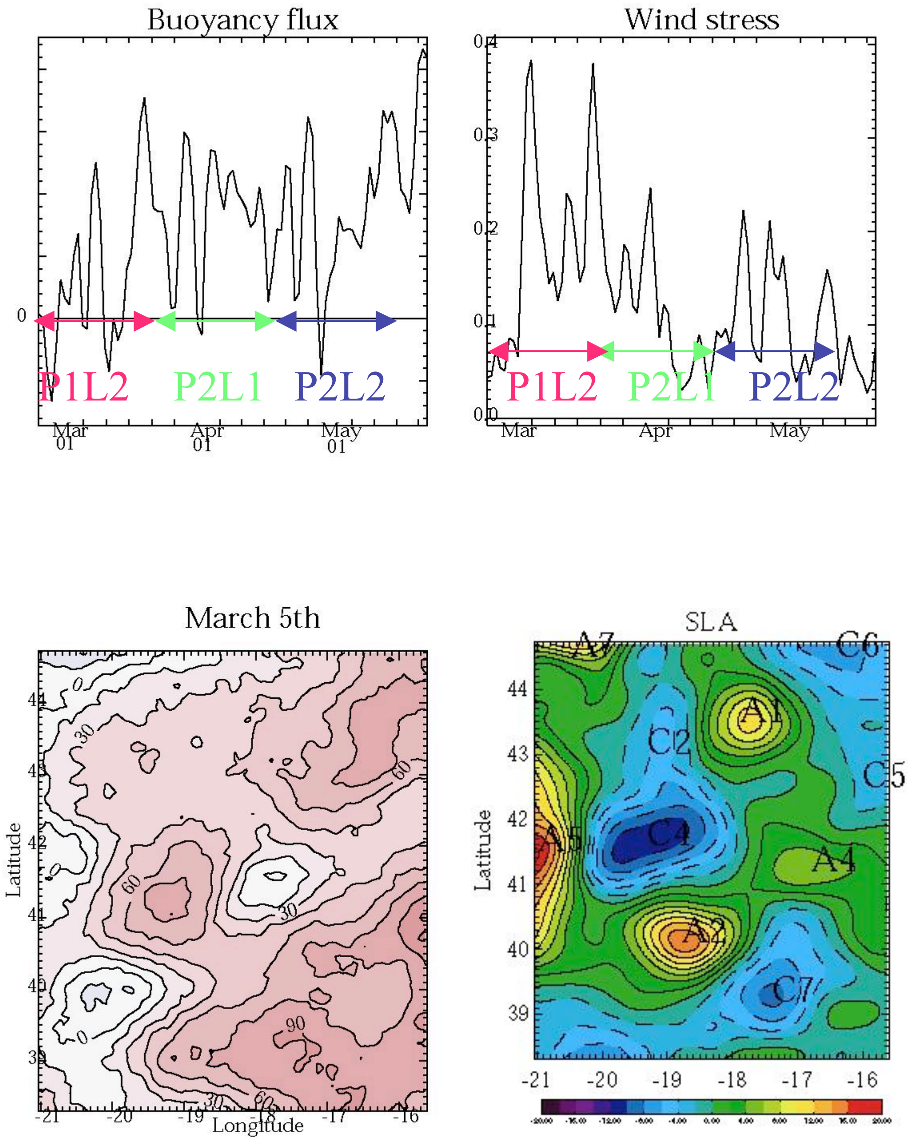




INITIAL STATE, POMME 1 LEG1

P1L1 : Initial state

- Mesoscale structures : surface intensified except A1
- Front : boundary between C4 and A2
- Nitrate : 4 to 7 mmole/m3
- North-South MLD gradient : 250m to 100m
- EKE : 90 cm^2/s^2



Atmospheric forcing

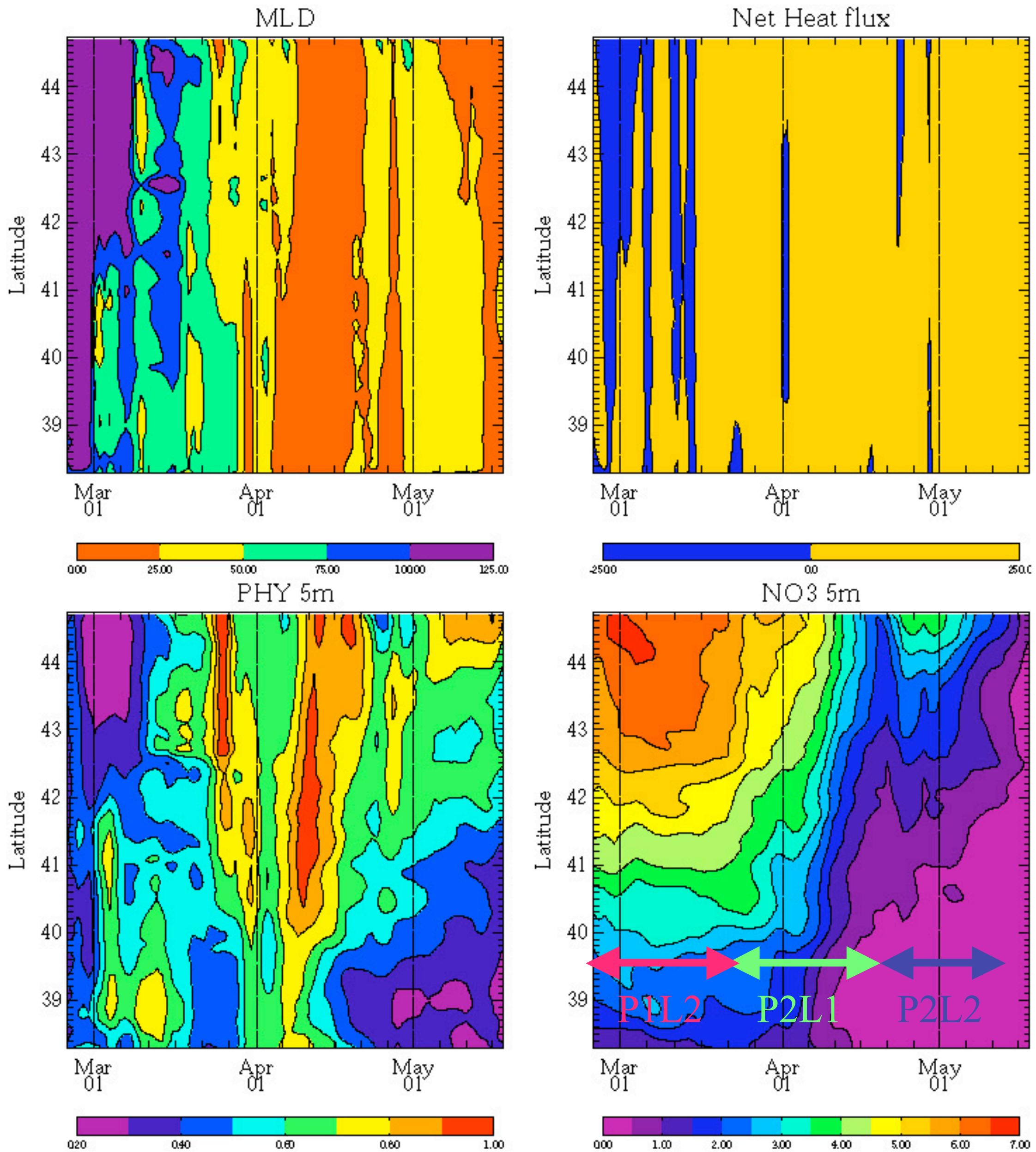
•Particular effort to get precise estimate of atm. fluxes, from shipboard + satellite + bulk (Caniaux et al.)

•Fluxes show high variability

•Mean : Seasonal warming

•Strong intermittency : atmospheric synoptic depressions, during P1L2 and P2L2

•Mesoscale structures : warm anomaly in the heat flux caused by the cold SST anomaly in cyclone C4



Latitude / Time evolution

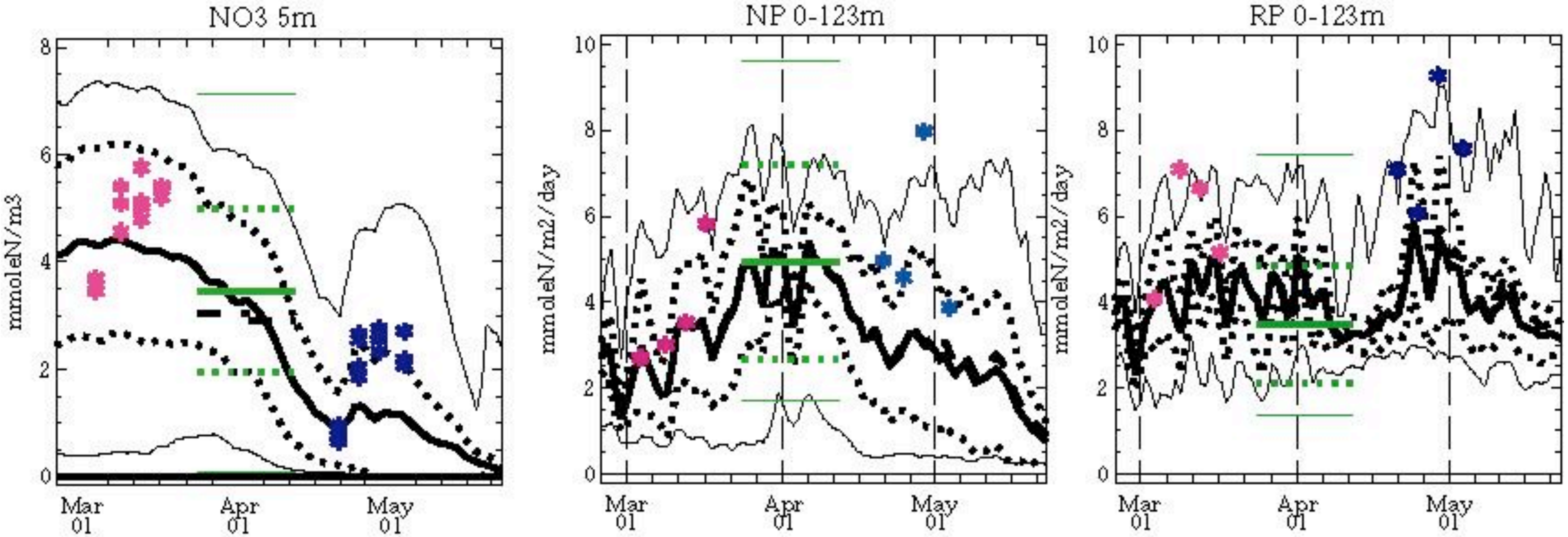
•MLD retreat : slow and intermittent (Paci et al.)

•NO3 consumption slow during P1 (deep-mixing), although intermittent phytoplankton increase

•Most significant decrease in NO3 occurs during P2L1

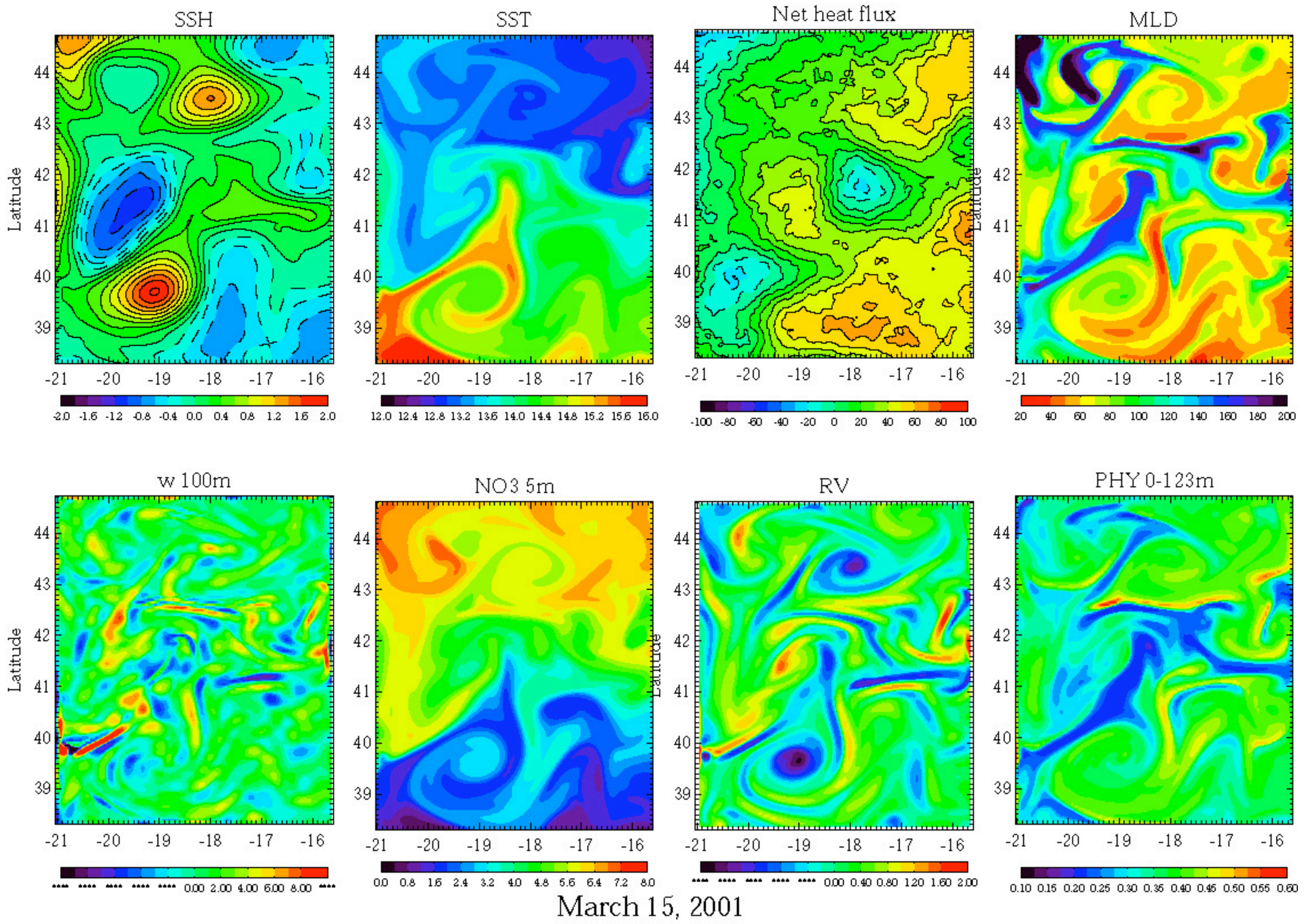
•Secondary bloom during P2L2 in the north

Nitrate and Productions : comparison with data



- General good agreement with data
- f-ratio of 0.5 : DOM as source for regeneration
- understimation during P2L2 : absence of diurnal cycle of MLD
- Same amplitude of the space and time variations

Early bloom



Heat flux
mesoscale forcing

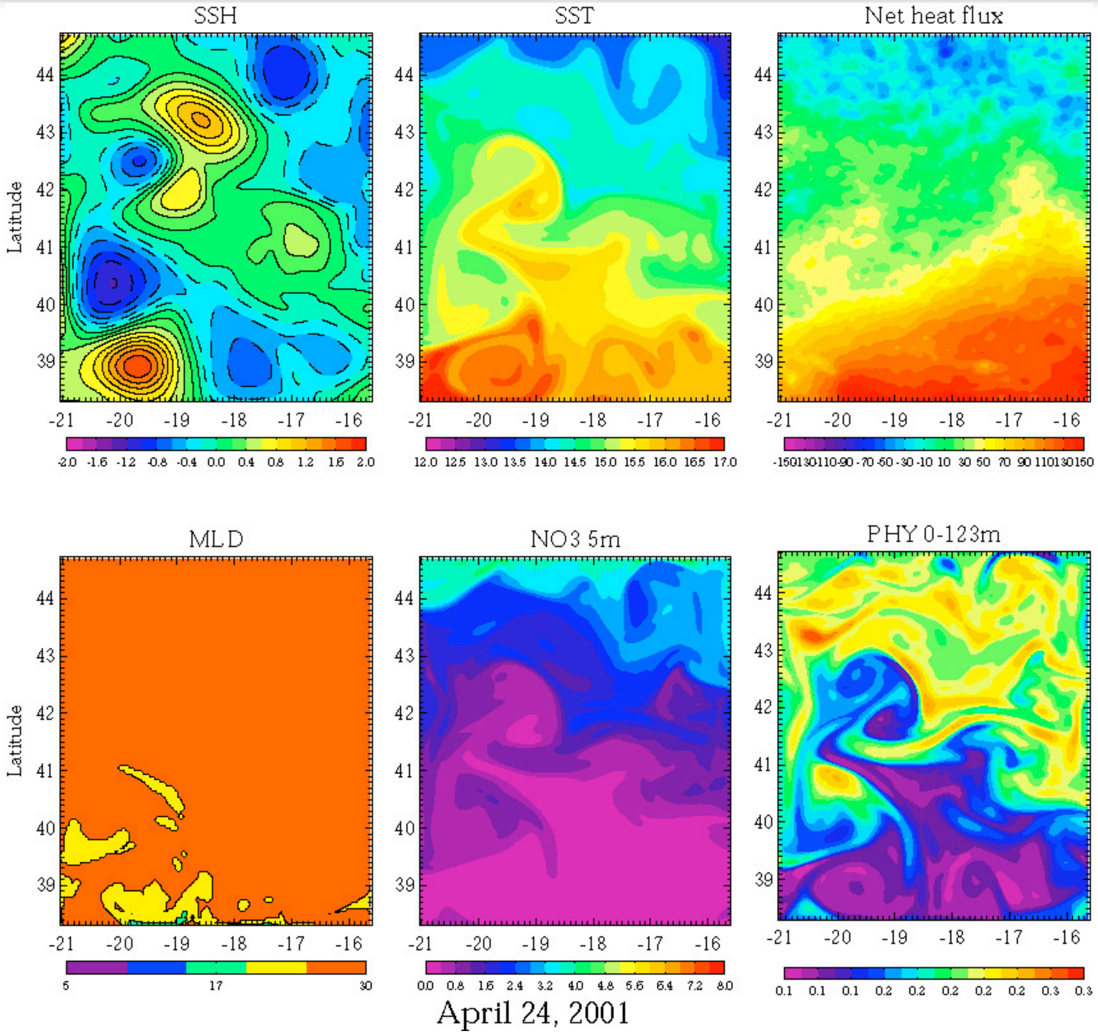
↓

Eddy stirring
MLD filaments

↓

Light control
Phytoplankton
filaments

Late bloom



Large scale
Nutrient gradient

↓

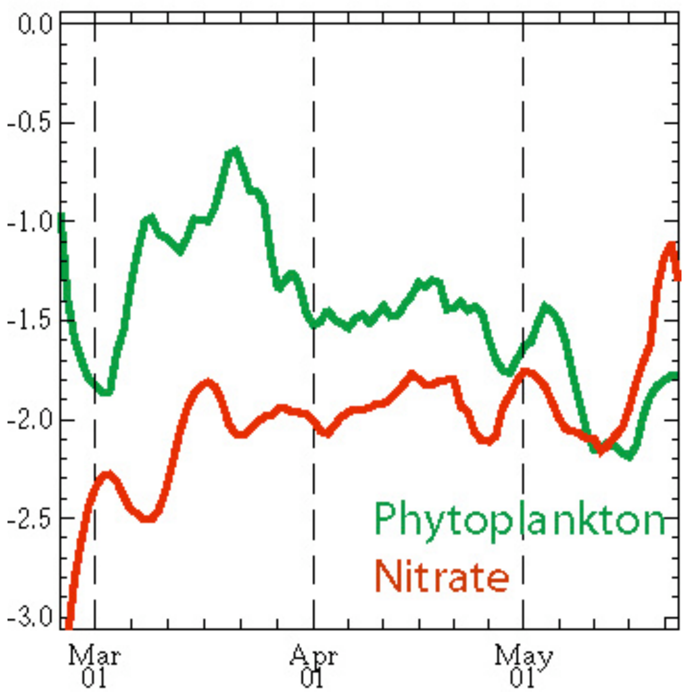
Eddy stirring
Horizontal mixing

↓

Nutrient control
Phytoplankton
filaments

Sub-mesoscales evolution

Spectral slope



Phytoplankton switches from :

•Very energetic small scales (forced at small-scales)
•Less energetic small scales (forced by the large scale)

Conclusions

- Model was able to restitute the full spatio-variability of the bloom
- Same amplitude for space and time variability : confirmation of the strong asynopticity in the data
- Submesoscale structures :
    - Early bloom : result from MLD filaments
    - Late bloom : result from nutrient filaments

⇒ Annual cycle, C and O2, more sophisticated biological model