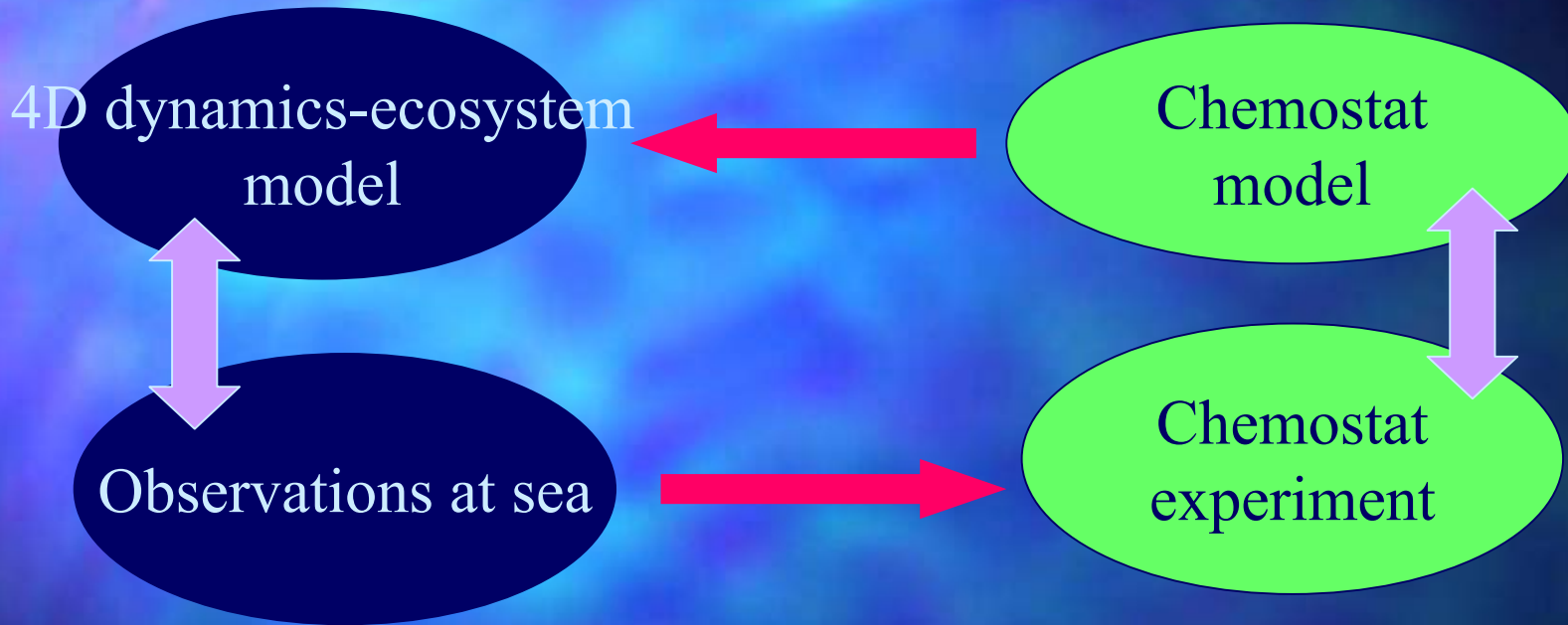# A 4D-mesoscale map of the spring bloom during the POMME experiment:
Results of a prognostic model

M. Levy, M. Gavart, L. Memery, G. Caniaux, A. Paci, et al.

In the frame of an experiment at sea (POMME) : combine two approaches (field/lab)

4D dynamics-ecosystem model ← Chemostat model

Observations at sea → Chemostat experiment

- Rate of change of environmental variables
- Model errors derived from model data comparison

- Improve the representation of primary production
- Reduce model errors

Outline

- Brief presentation of POMME
- Results of the 4D hydrodynamics-biogeochemical model developed for POMME
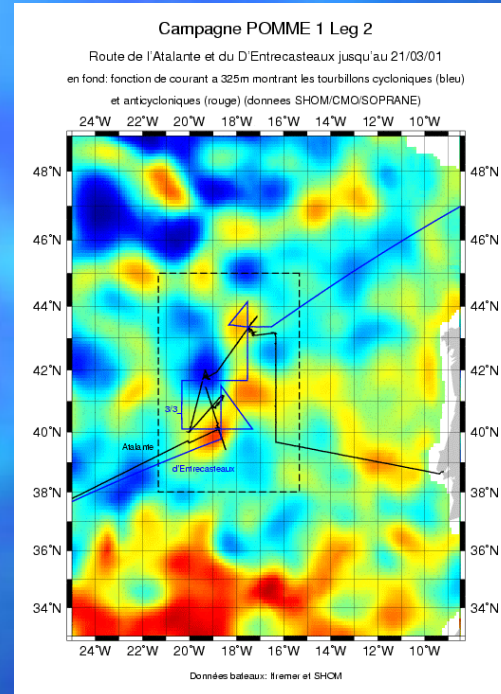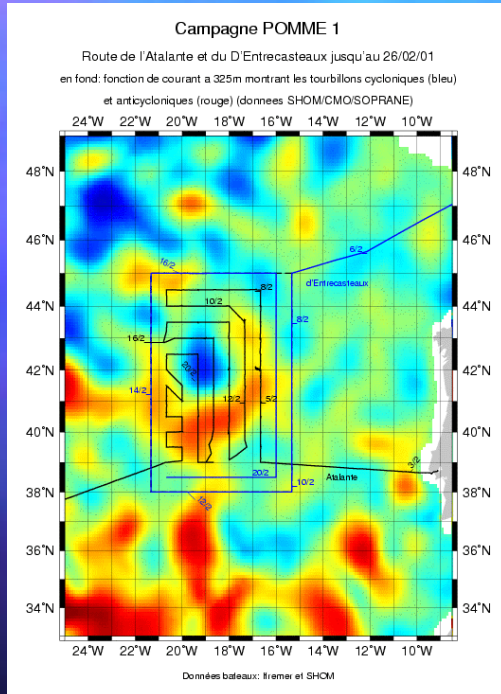- Scales in the ocean model/the chemostat

POMME general objectives
## Program Ocean Multidisciplinary MEsoscale

Role of mesoscale eddies on the biogeochemical properties of subducted mode waters in the NE Atlantic

- Role on the spring bloom
- Role on subduction
- Timing of the bloom versus subduction

POMME observations at sea

- Area : 7 x 5 degrees

- 1 or two R/V present during 3 months in 2001

- Legs 1 : CTD stations, 50 km, 3 weeks : coverage of the whole area (maps) with strong asynopticity

- Legs 2 : 4 stations visited, more intensively (longer biological experiments)
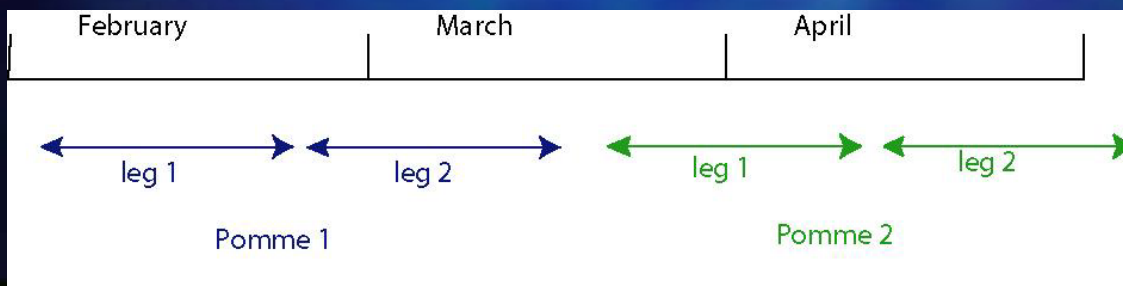
Objectives of this model study

- Give a synoptic and integrated view of the area during each cruise

- Establish budgets of production and export

- Get a better understanding of the coupling processes at mesoscale and sub-mesoscale during the bloom regime
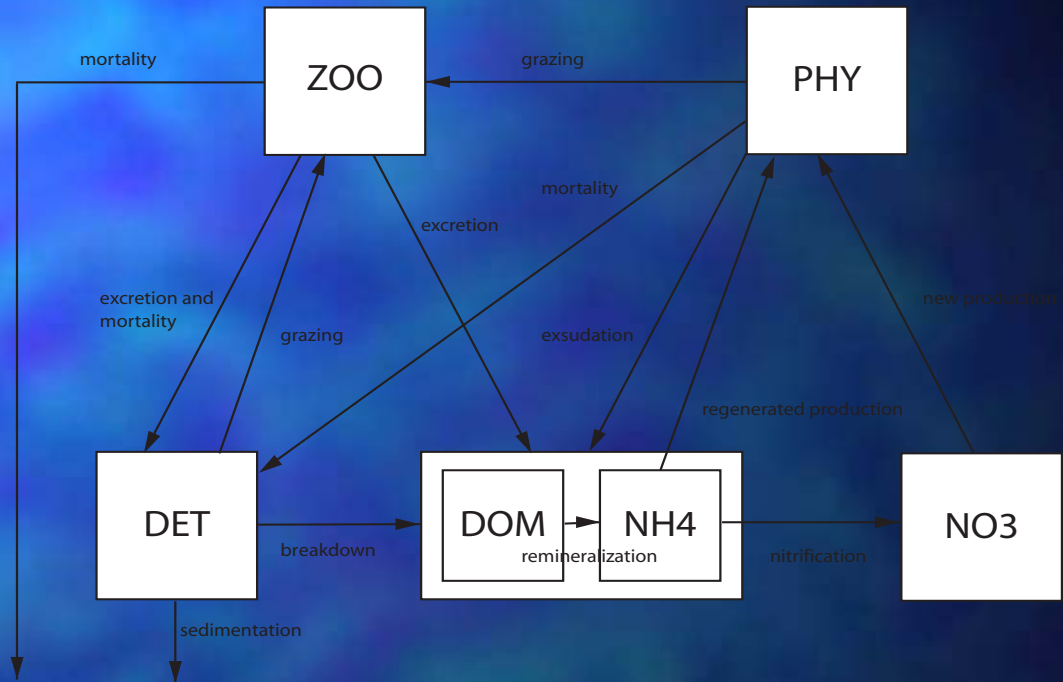
Biogeochemical model

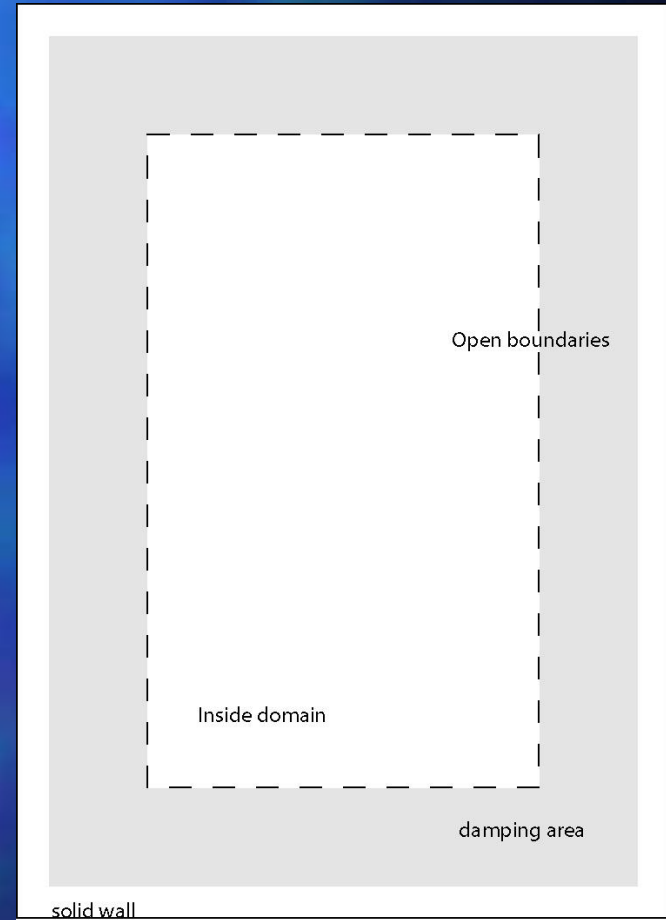Nitrogen currency

Chl: N ratio diagnosed
   from irradiance

No diurnal cycle

No average in the ML

Physical model

-Primitive equations OPA

-5 km horizontal resolution

-open boundaries

-4 months of simulation
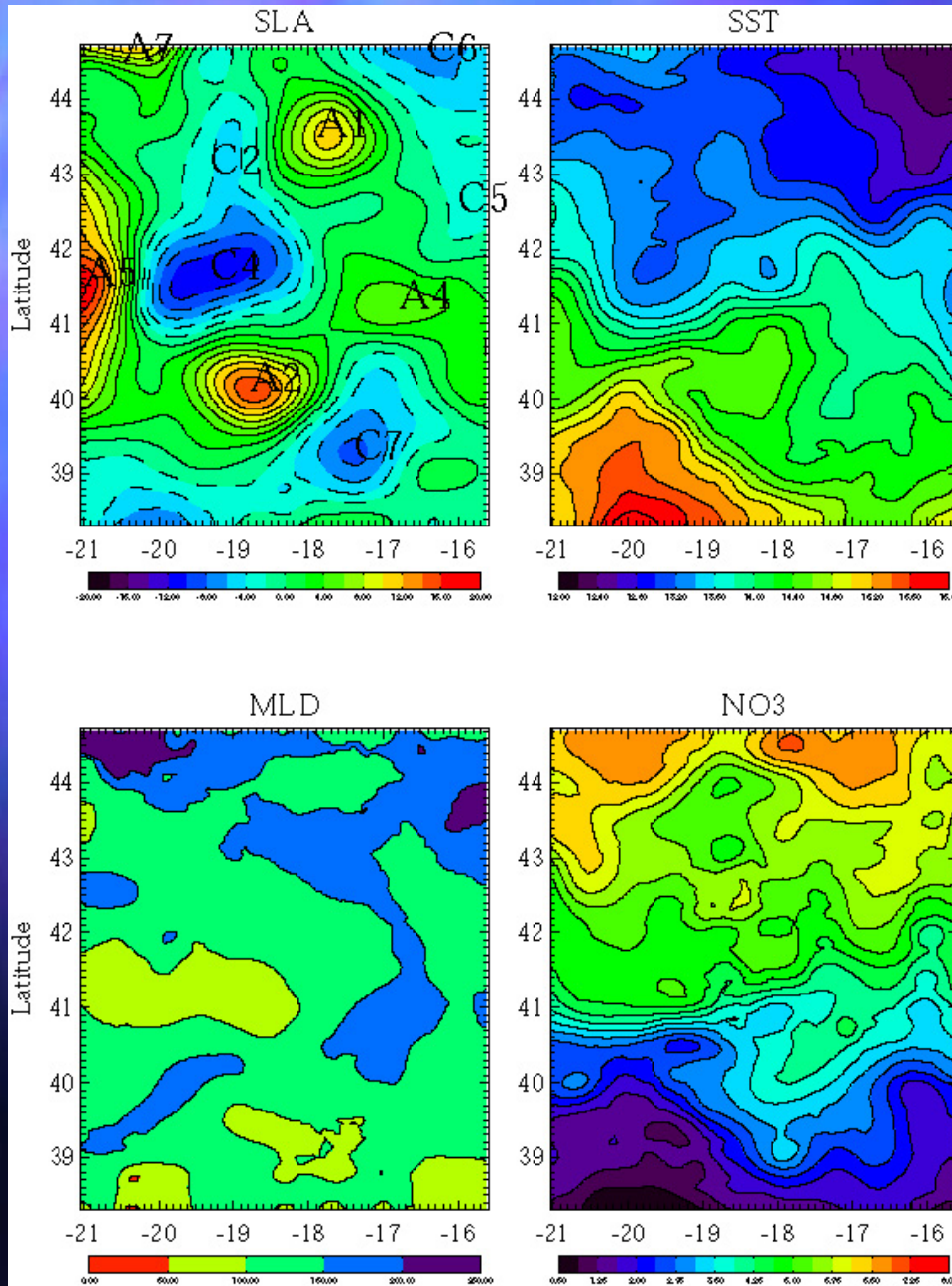
-In the damping area : restore T, S
towards Pomme 2 leg 1

Open boundaries

Inside domain

damping area

solid wall

Initial state

INITIAL STATE, POMME 1 LEG1

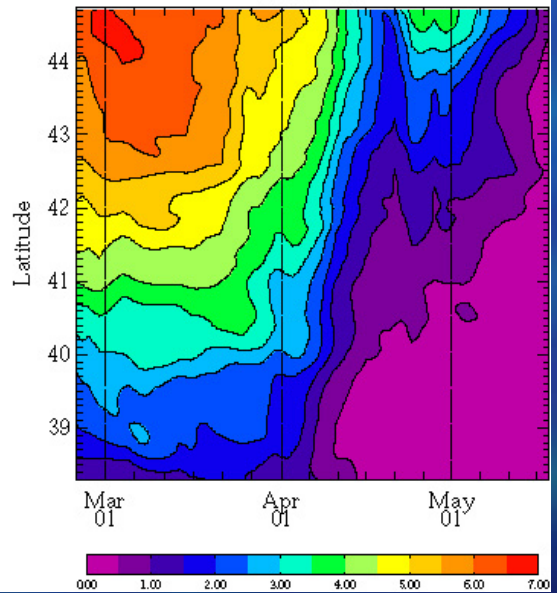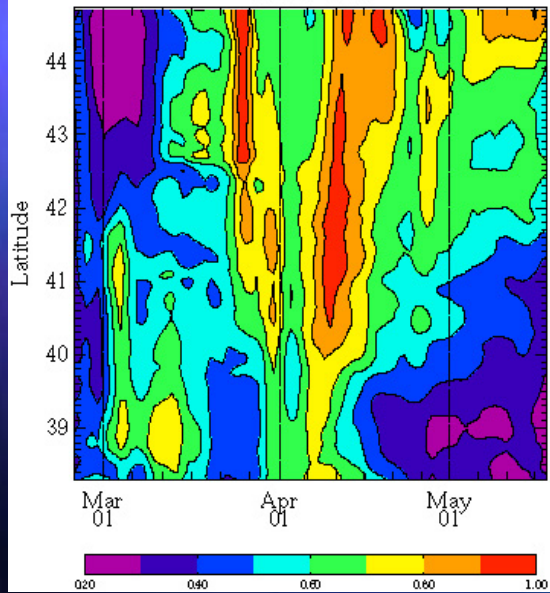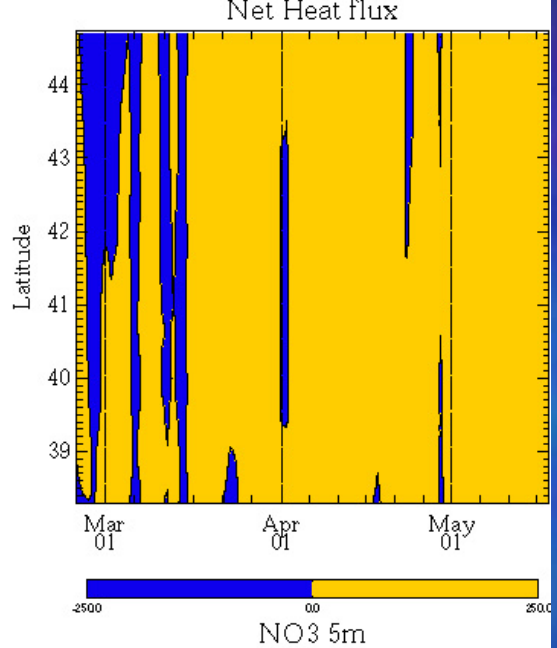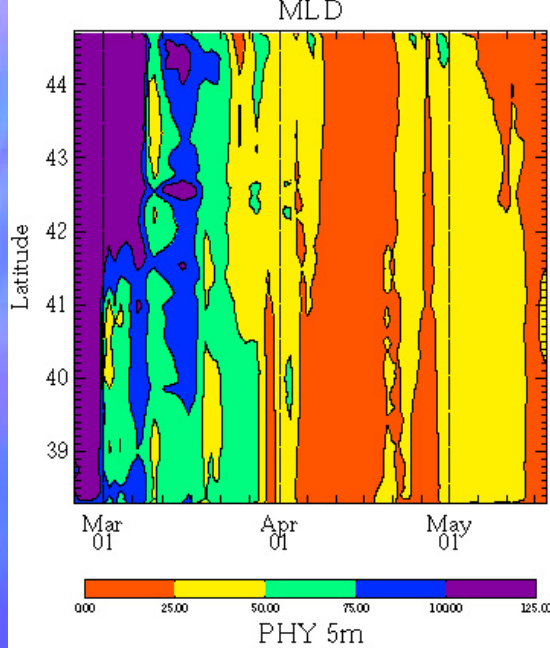Derived from optimal interpolation of P1L1 data (+ satellite altimetry and floats for SLA + aging for SST)

Mesoscale structures : surface intensified except A1

Front between two different water masses : boundary between C4 and A2

North South MLD gradient

Zonal evolution

Intermittent heat flux : slow stratification (6 weeks)

NO3 consumption rather slow during P1 (deep-mixing), although intermittent phytoplankton increase
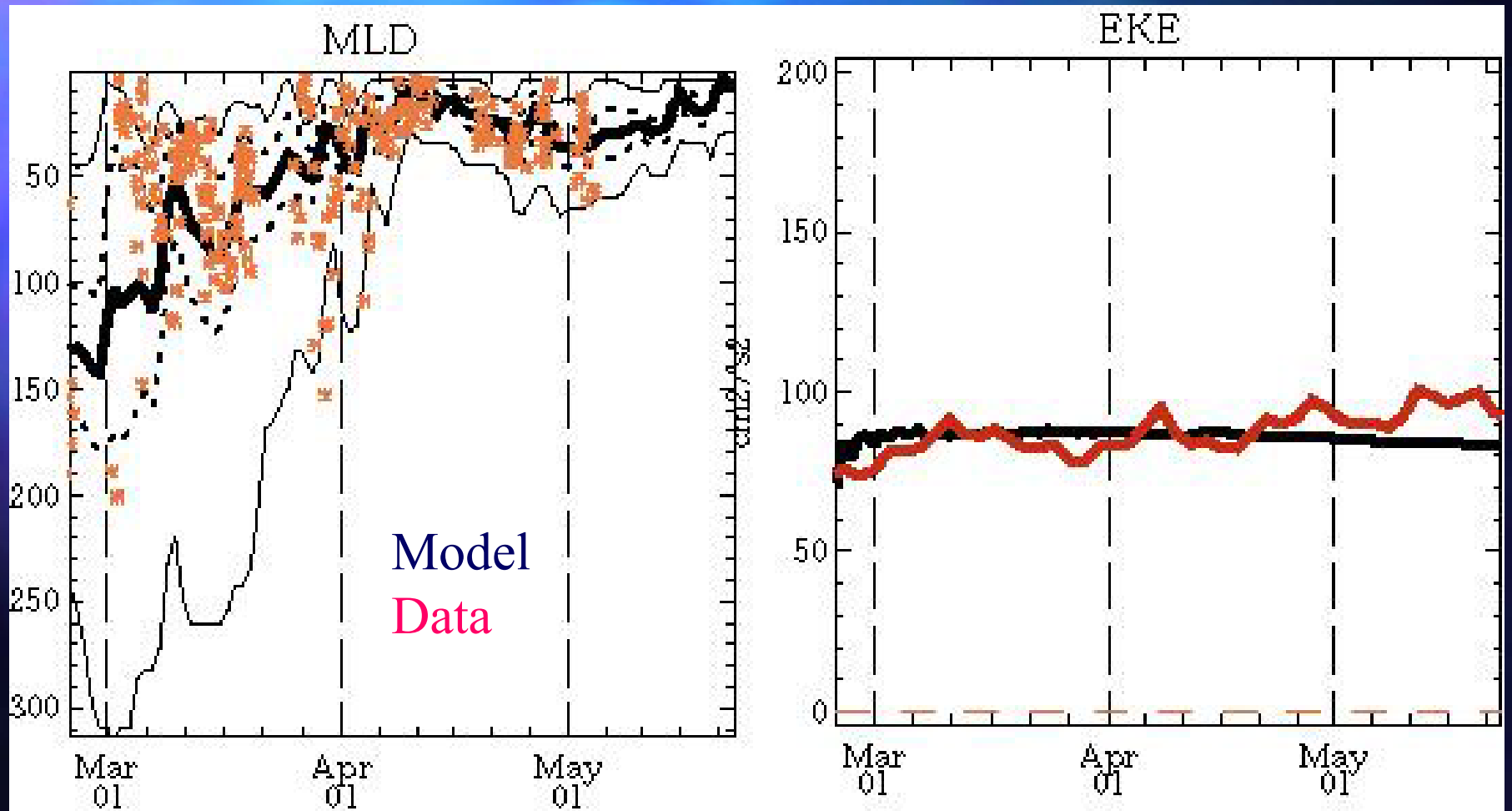
Most significant decrease in NO3 occurs during P2L1

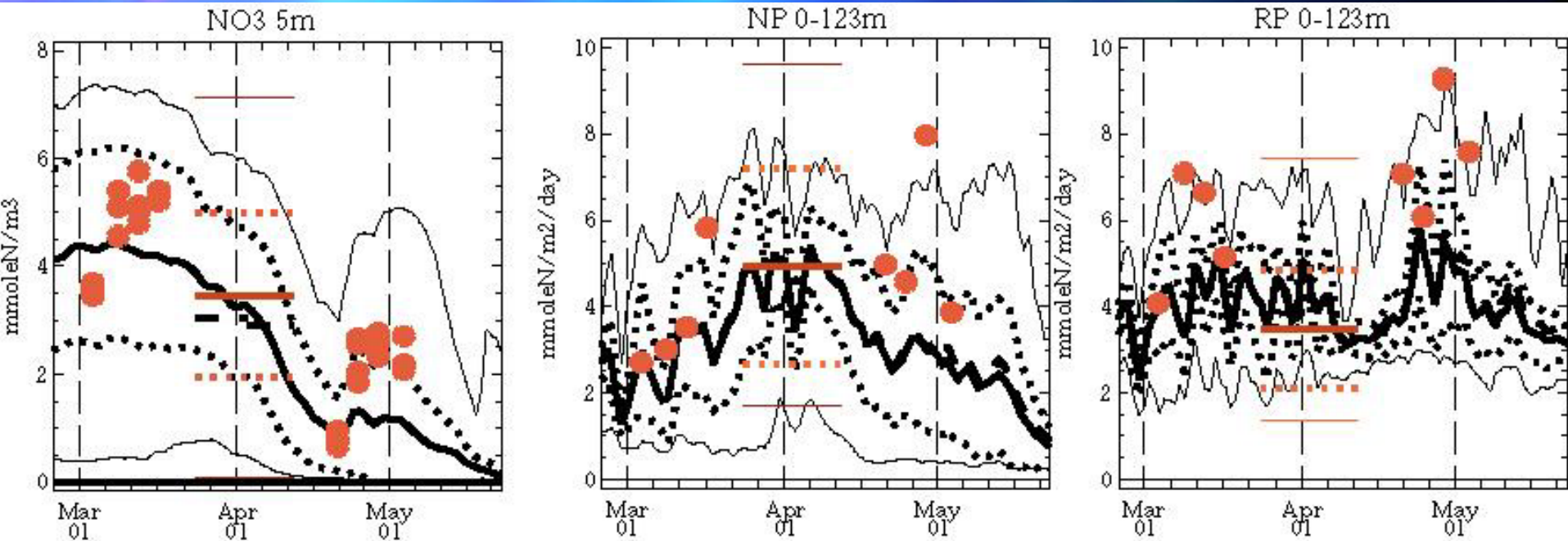Secondary bloom during P2L2 in the north

Averaged evolution of the physics

MLD

EKE

Model
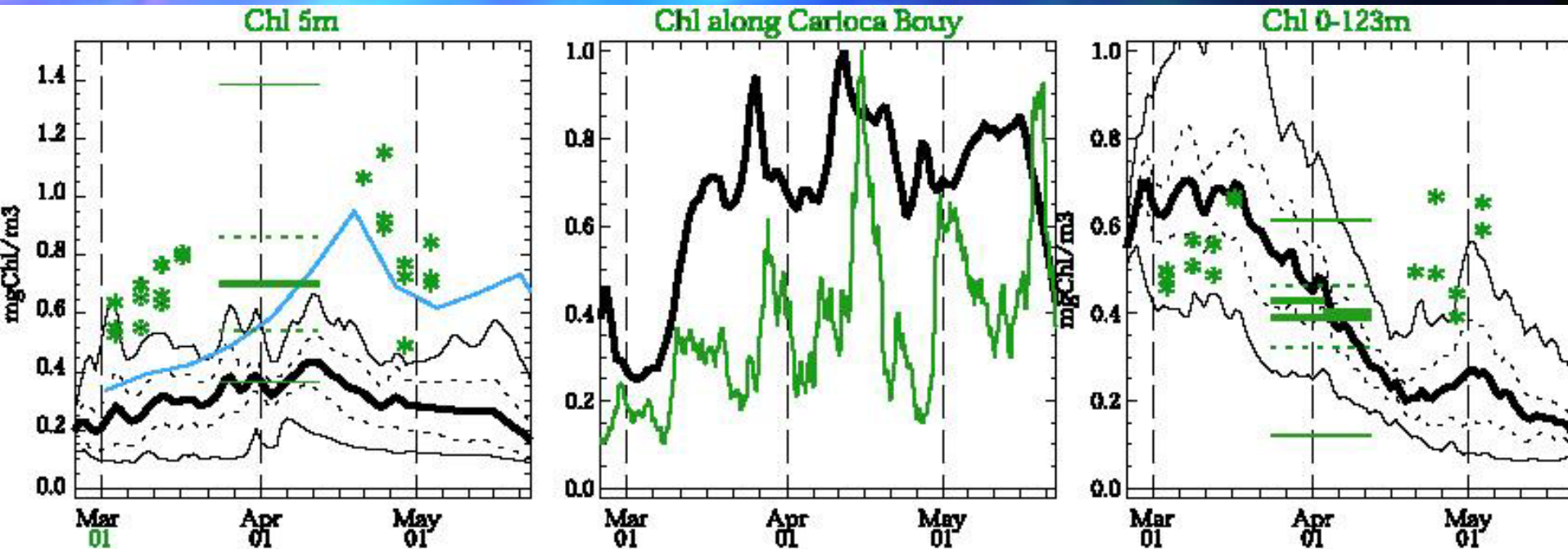Data

# Averaged evolution of nitrate + PP

NO3 5m — NP 0-123m — RP 0-123m

-good agreement with data : timing + amplitude

-slow decrease of nitrate during P2: zooplankton control

-max f-ratio of 0.5 : dom as source for regenaration

-understimation during P2L2 : absence of diurnal cycle of MLD

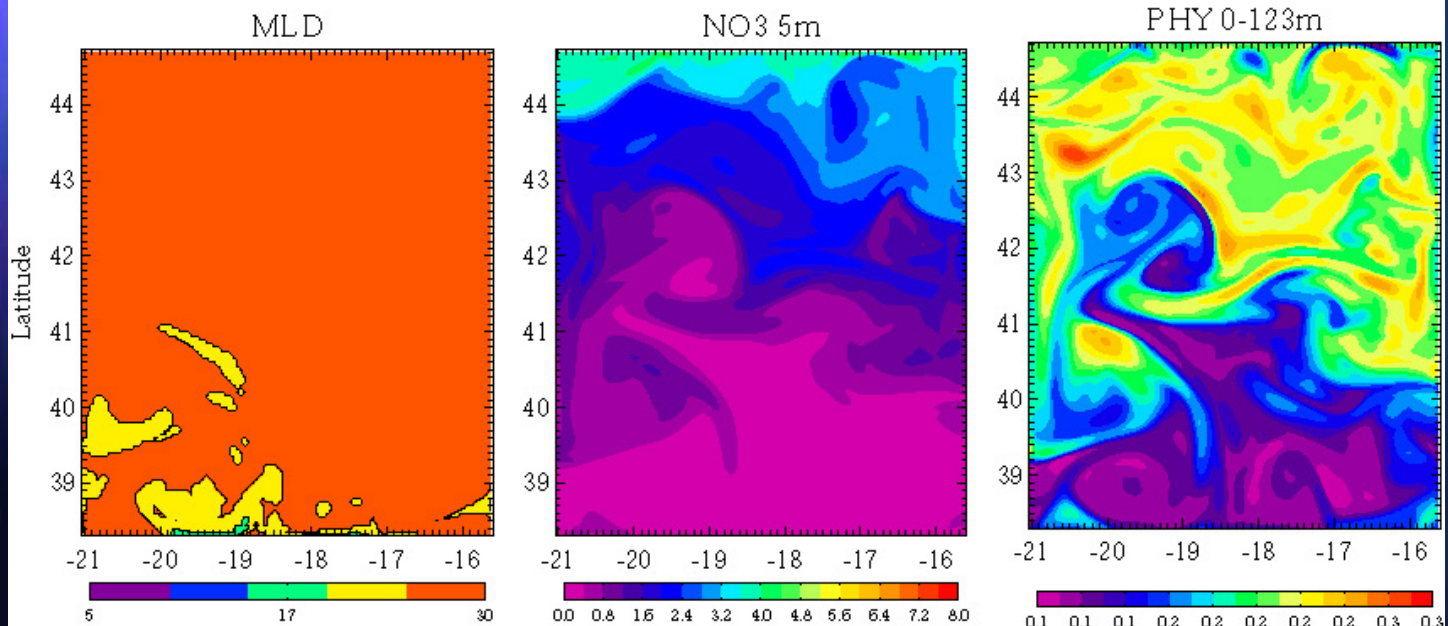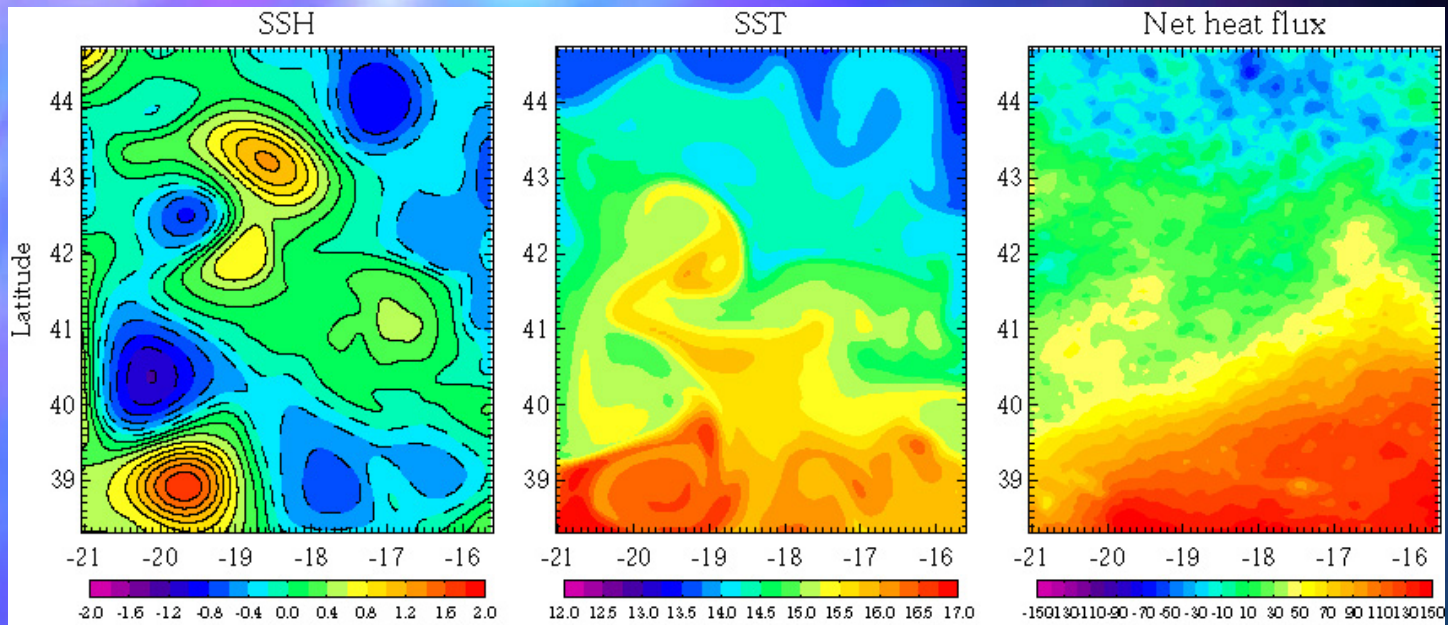- Not shown : zooplankton, export flux, ammonium

Averaged evolution of chlorophyll

- increase of surface Chl and decrease of integrated Chl in model and data
- underestimation of surface Chl
- overestimation of integrated Chl
- max surface Chl one week too early
- correct high-frequency variability

SSH   SST   Net heat flux   MLD

k^{-3} k^{-2} k^{-1}

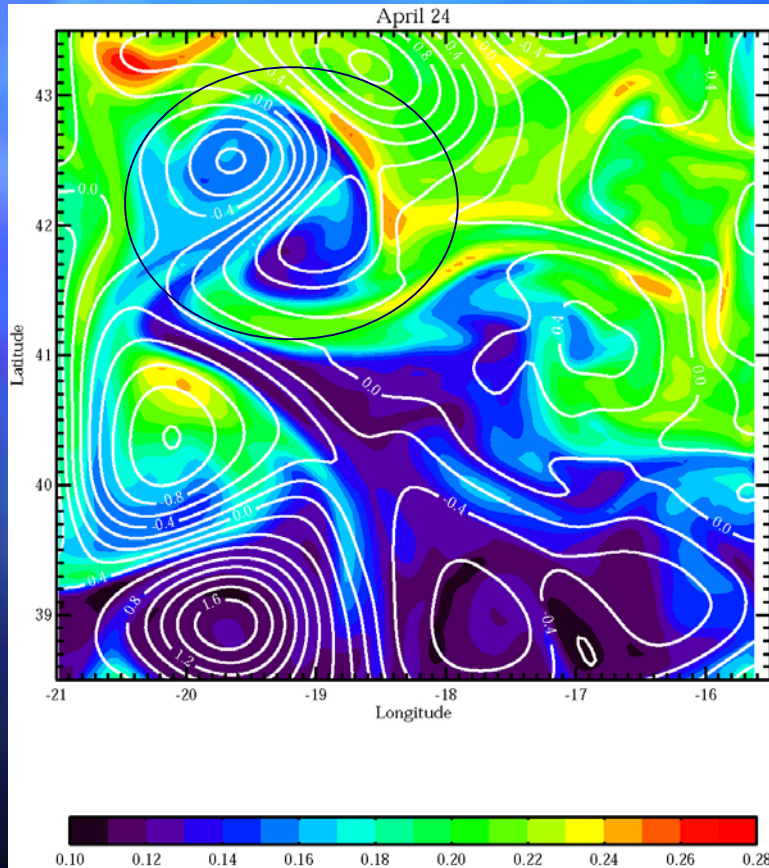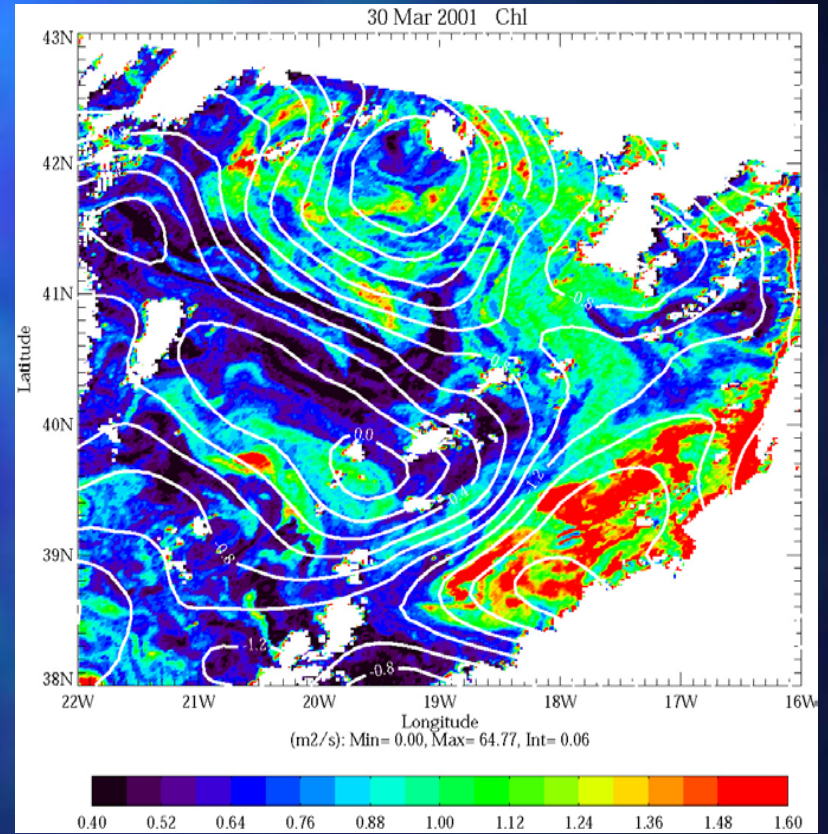w 100m   NO3 5m   RV   PHY 0-123m

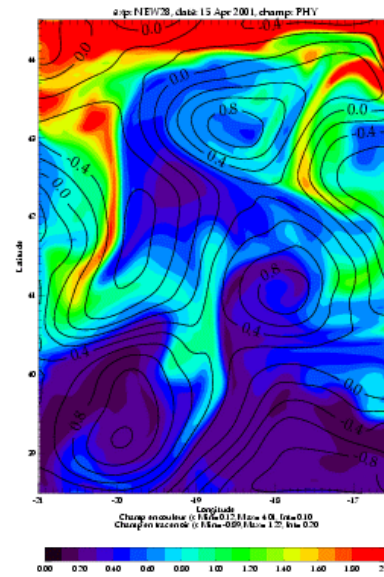k^{-2} k^{-1} k^{-1}
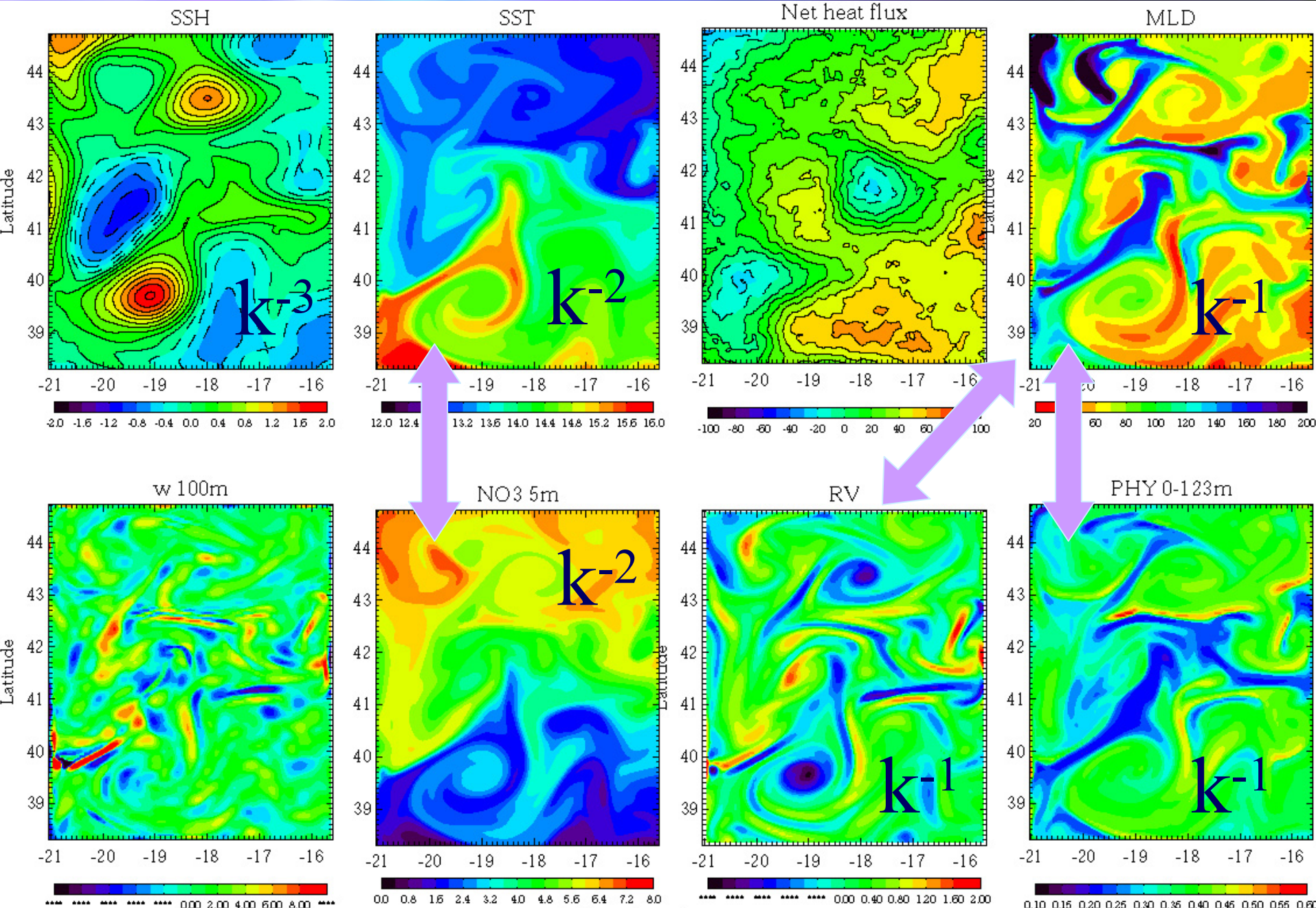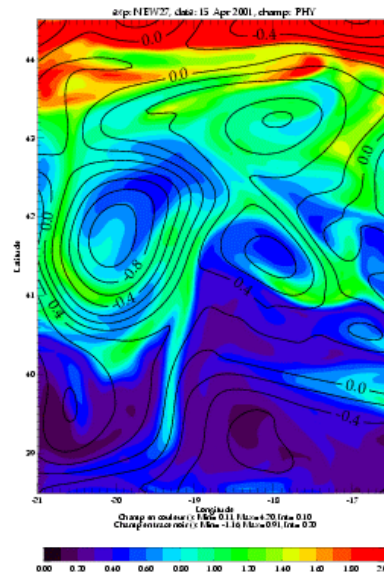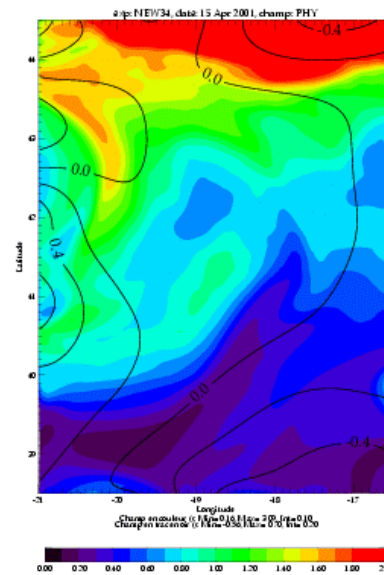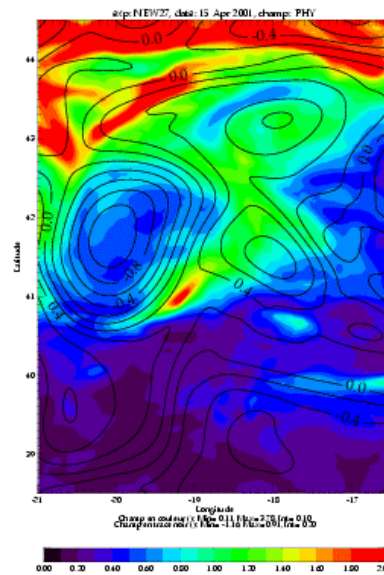
March 15, 2001

April 24, 2001

Model

Seawifs

Sensitivity experiments : role of filamentary structures

Free run

Run with
Assimilation SLA

Run with no
Advection bio

Dissipatif run

Primary production

Evolution Temporelle, exp: NEW, champ: TNO3PHY

latitude in [38.5, 44.5] - (121 points) longitude in [-21.0, -16.5] - (90 points)
Champ en couleur (): Min= 0.71, Max= 7.90
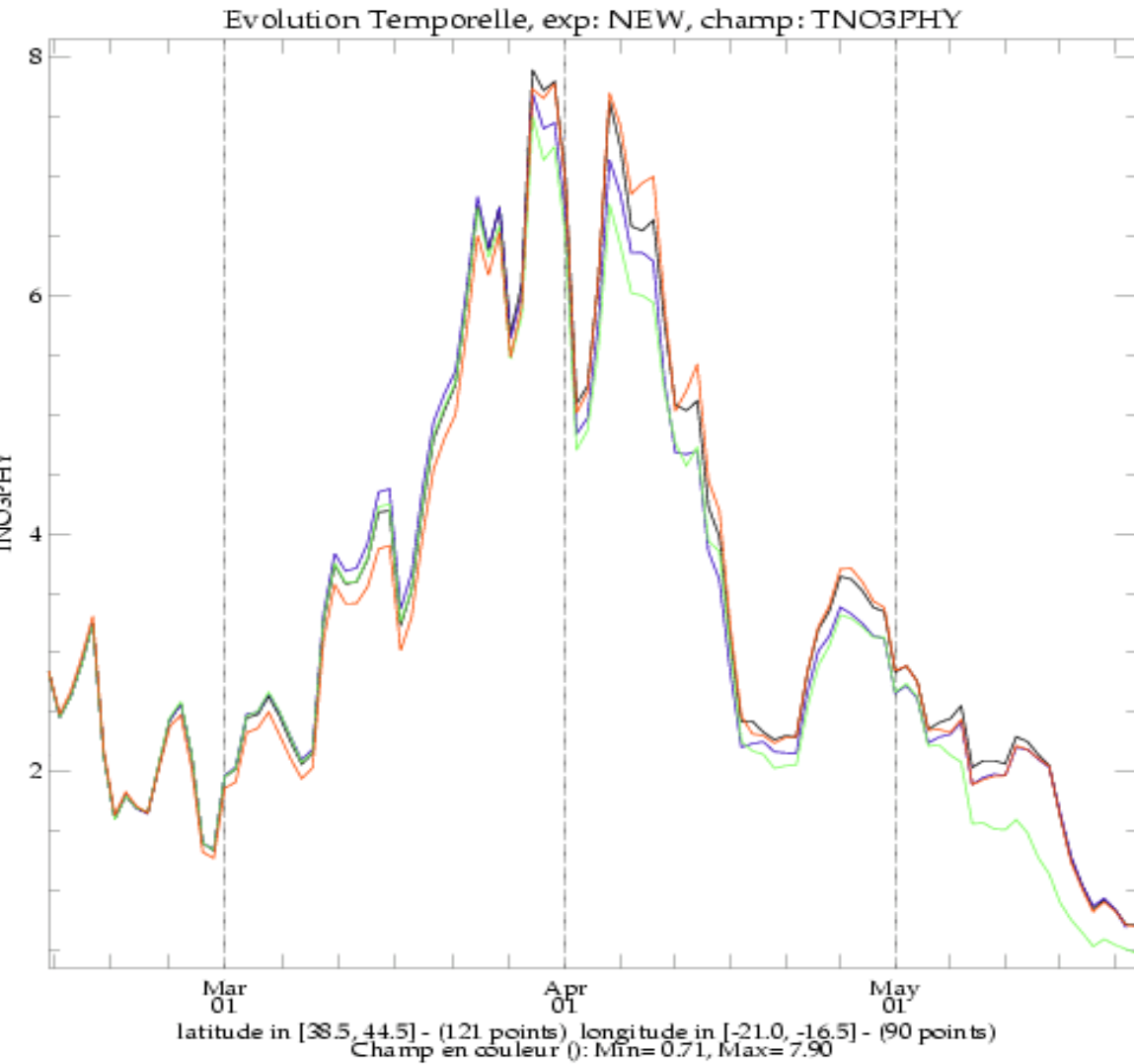
Free run
Assimilation SLA
No advection for bio
Dissipative run

Controlling factors:

Initial nutrients

Atmospheric fluxes

Conclusion

- Model was able to restitute the full spatio-variability of the bloom with two major shortcomings
  - Chl
  - P2L2 bloom
- high spatio-temporal variability mirrored the variability of the MLD
- filamentary structures :
  - Result from stirring induced by the mesoscale eddies of larger scale forcing (nutrient, atmospheric forcing)
  - Weak contribution to the total PP budget

Scales

4D dynamics-ecosystem model

Vertical mixing

Chemostat model

Observations at sea

Chemostat experiment

10 km on horizontal

10 m on the vertical

1-2 days

10 cm
1 hour