Primary production variability
Driving physical mechanisms at different scales

A synthesis of different works in the frame of POMME

Marina Lévy (IPSL)

Y. Lehahn , J.-M. André, M. Gavart, L. Memery,
G. Caniaux , A. Paci, S. Roudesli

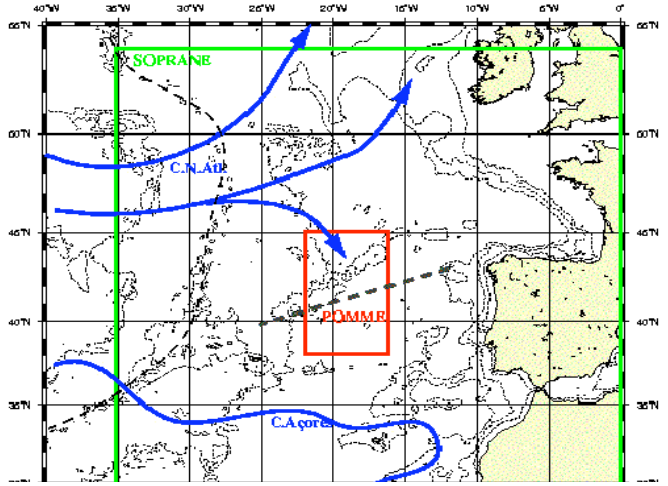
Outline

- Physical mechanisms can be view as a forcing of PP
  Physical forcings apply on different scales
  diurnal cycle to interannual variations
  regional scale to the submesoscale

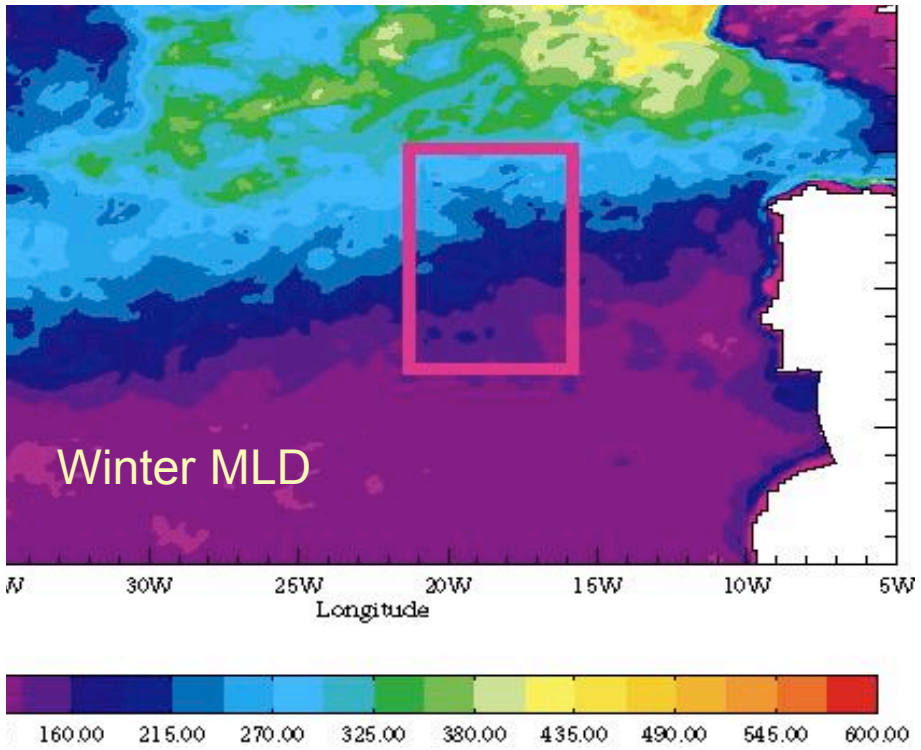
- For a specific region of the ocean : the NE Atlantic,
  To show how the combination of different approaches can help identify and quantify the forcing mechanisms, the scale on which they apply, and their relative contribution to the total variability of PP.

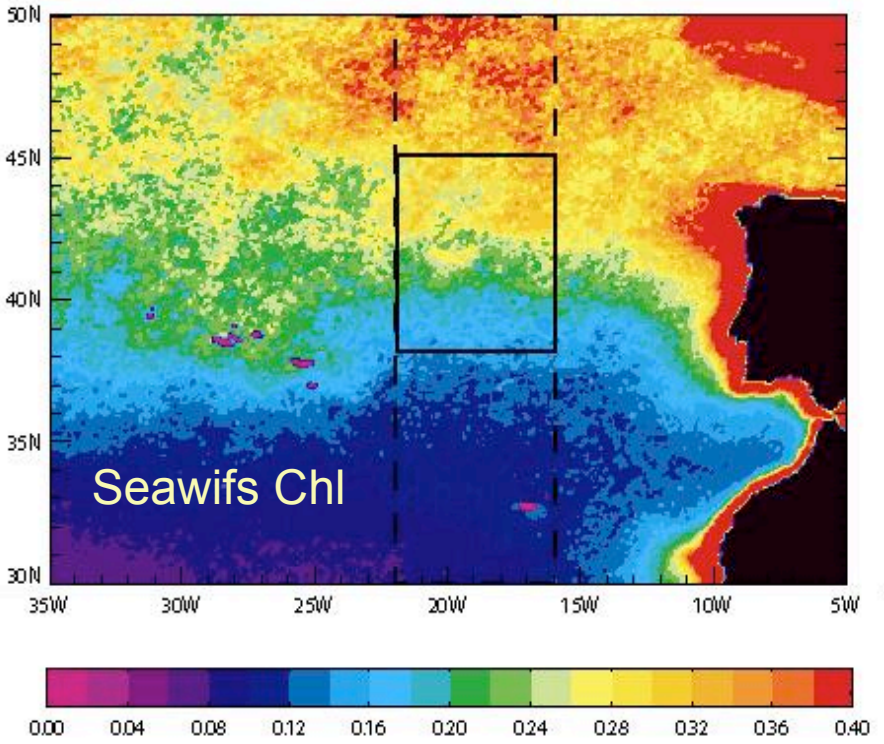
North-east Atlantic

1. Region of mode water formation
2. Large meridional variability
3. Intensive surveys in 2001 POMME



SCHL (mg/m^3)

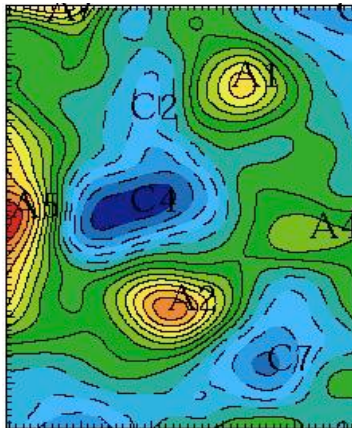




Regional (500 km)
Seasonal – annual

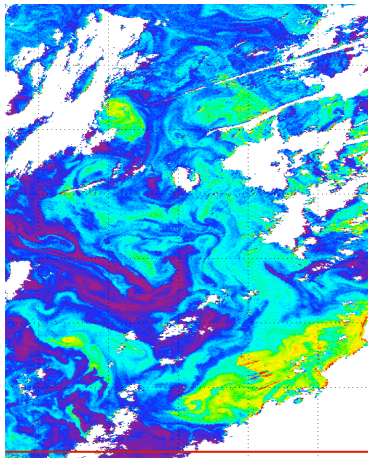
MLD (Clipper model)

Mesoscale (30-100 km)
3-6 months



SLA

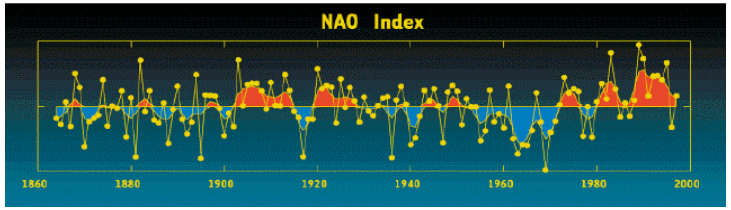
Sub-mesoscale (10 km)
week



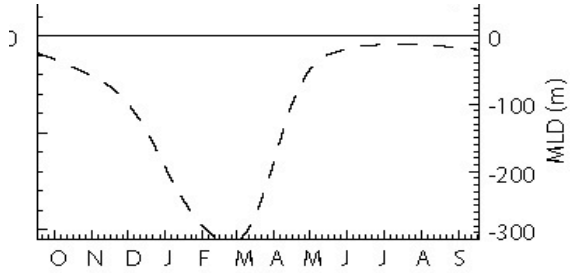
SeaWIFS Chl

Ocean dynamics scales

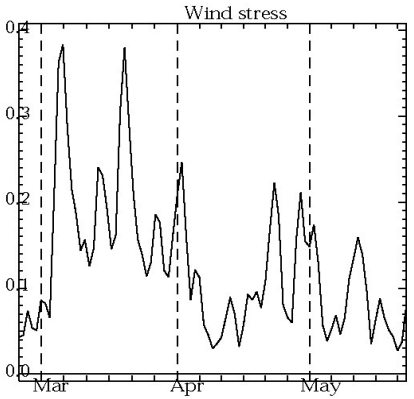
Interannual



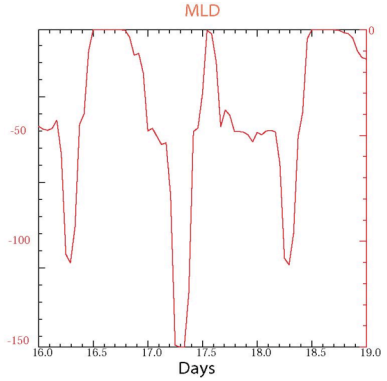
Seasonal



Synoptic



Diurnal



Atmospheric scales

APPROACH

•Regional, interannual, seasonal scales

Analysis of satellite data

•Mesoscale, submesoscale, intra-seasonal, synoptic scales

Analysis of 3D model outputs

•Diurnal variability

Lagrangian model

•Species variability : seasonal cycle, regional

1D model

Analysis of satellite data

Method

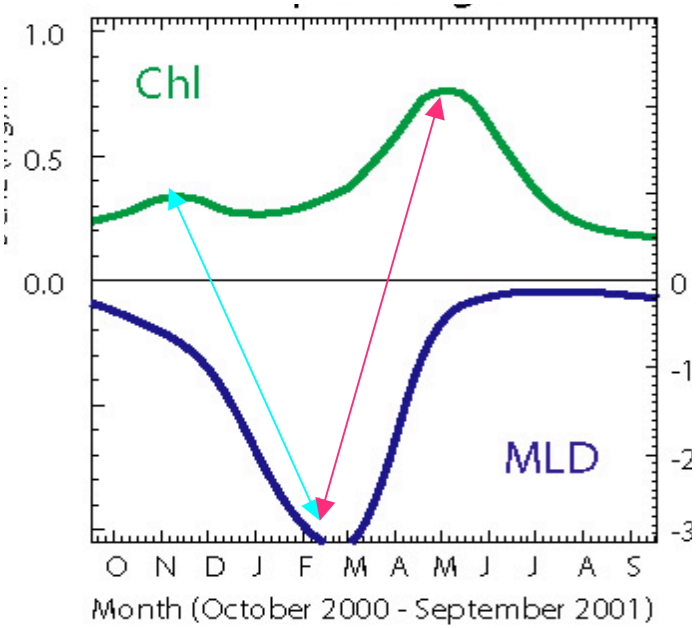
Compare :
- SeaWiFS images : 9km, 8 days composites
- MLD model outputs : CLIPPER, 1/6th degre, 5 days

Entrainement bloom

Spring bloom

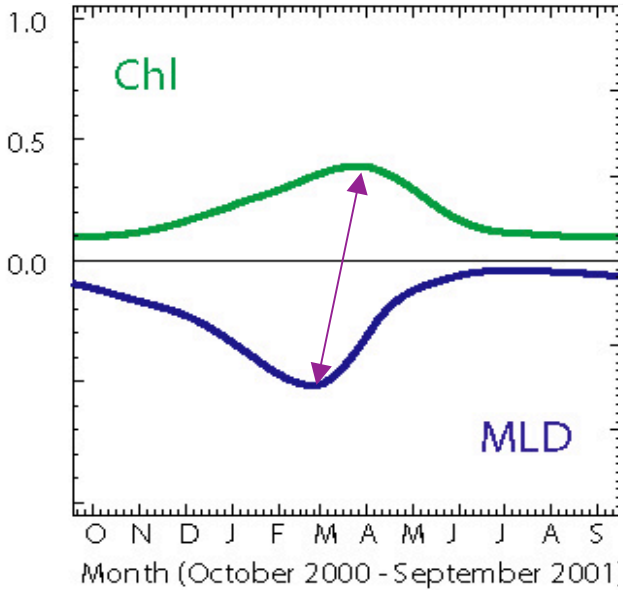
Composite bloom

Sub-polar cycling



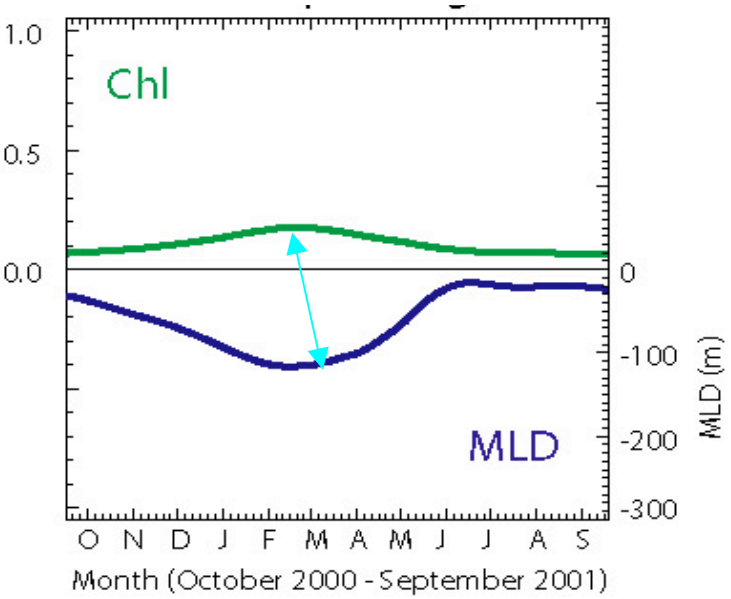
40-50N

Mid-latitude cycling



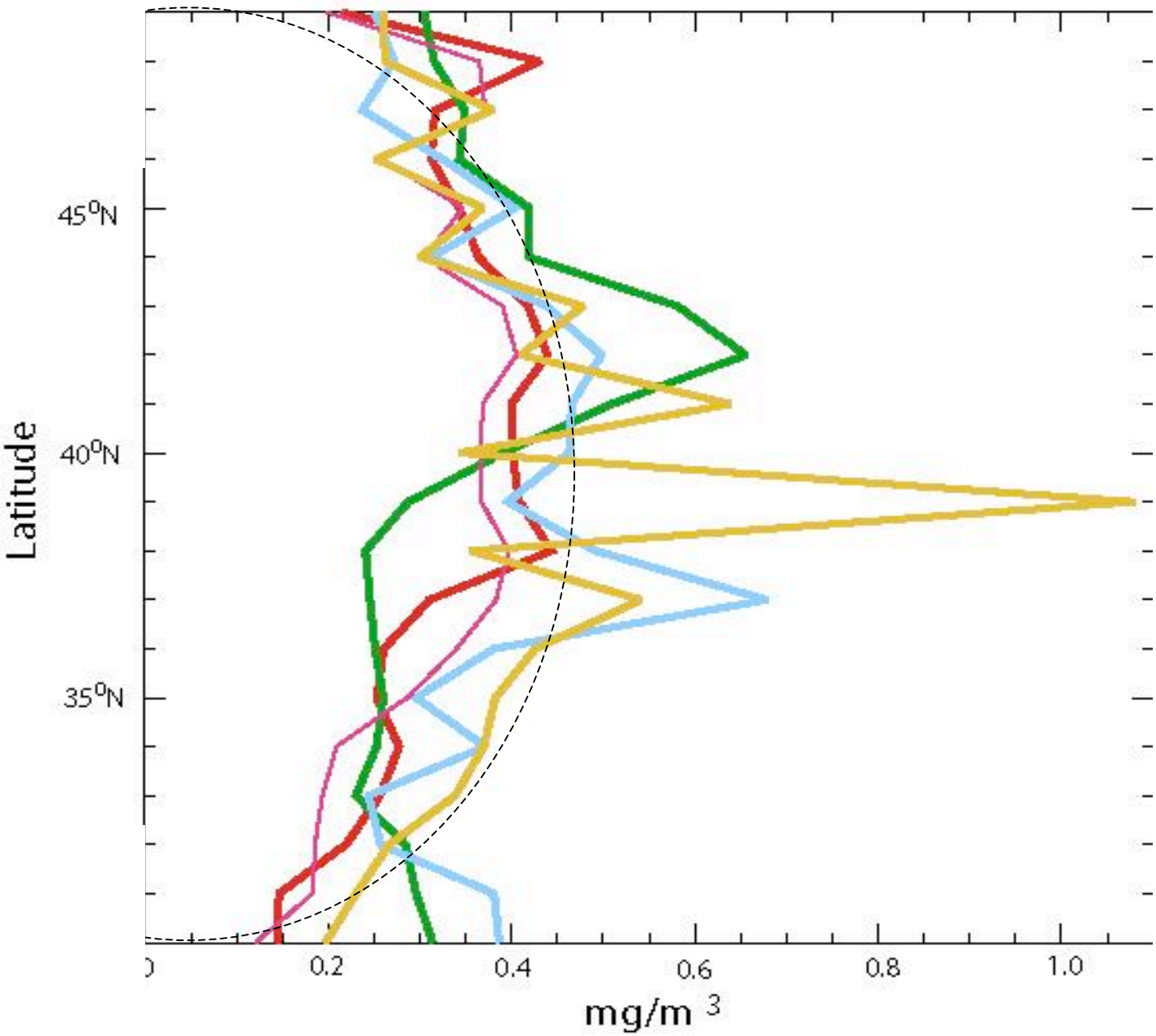
35-40N

Sub-tropical cycling

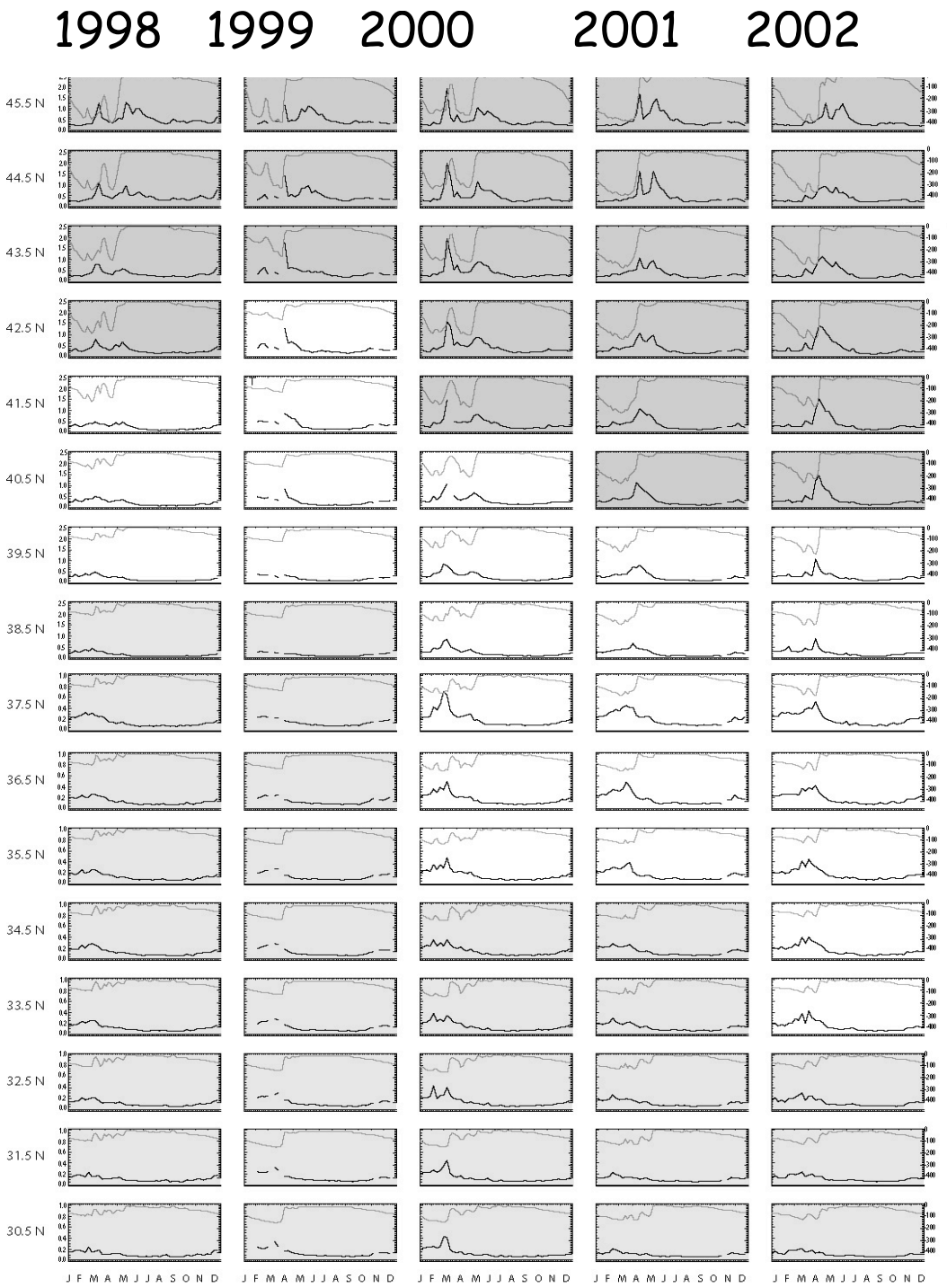


30-35N

Chl at the time of maximum winter MLD



Biological pump efficiency



45N

40N

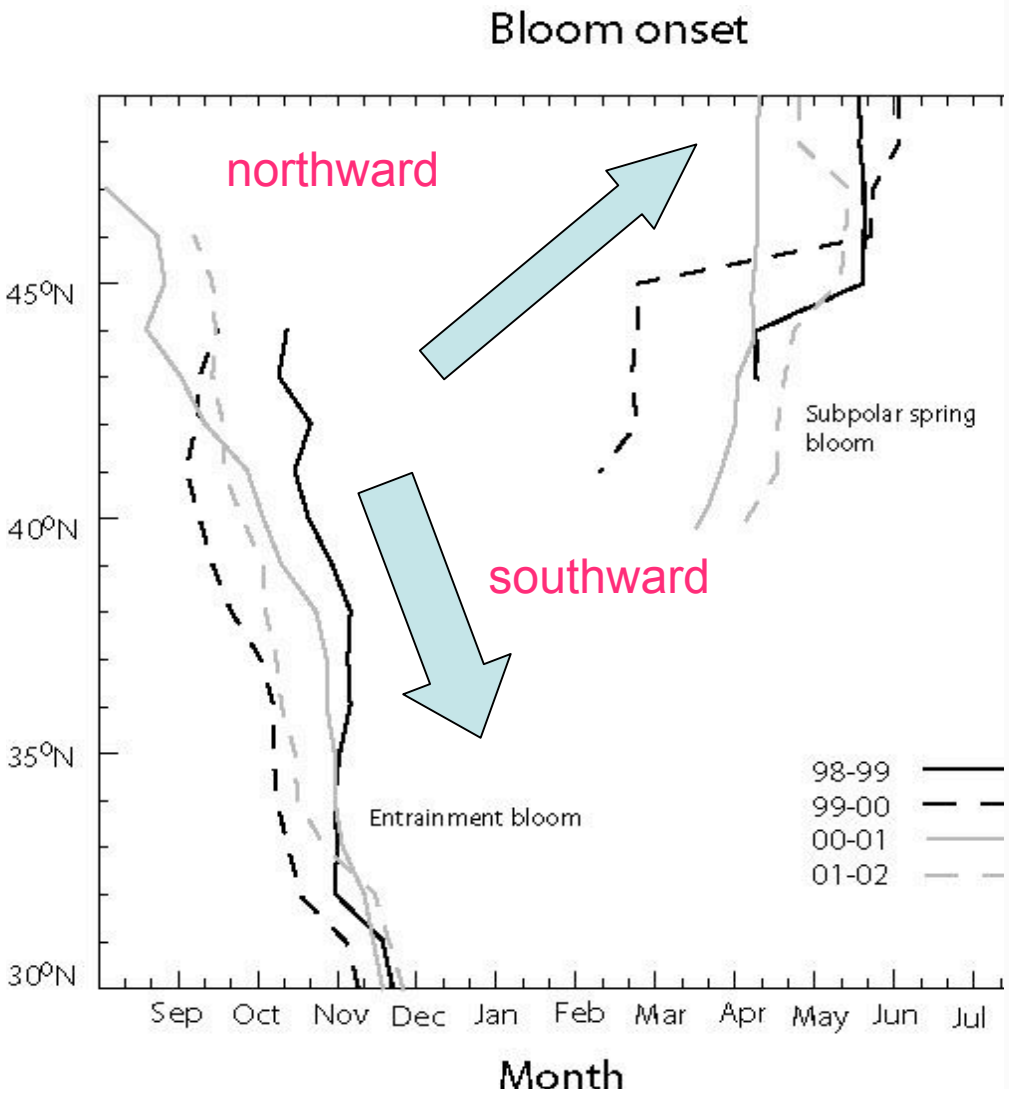
35N

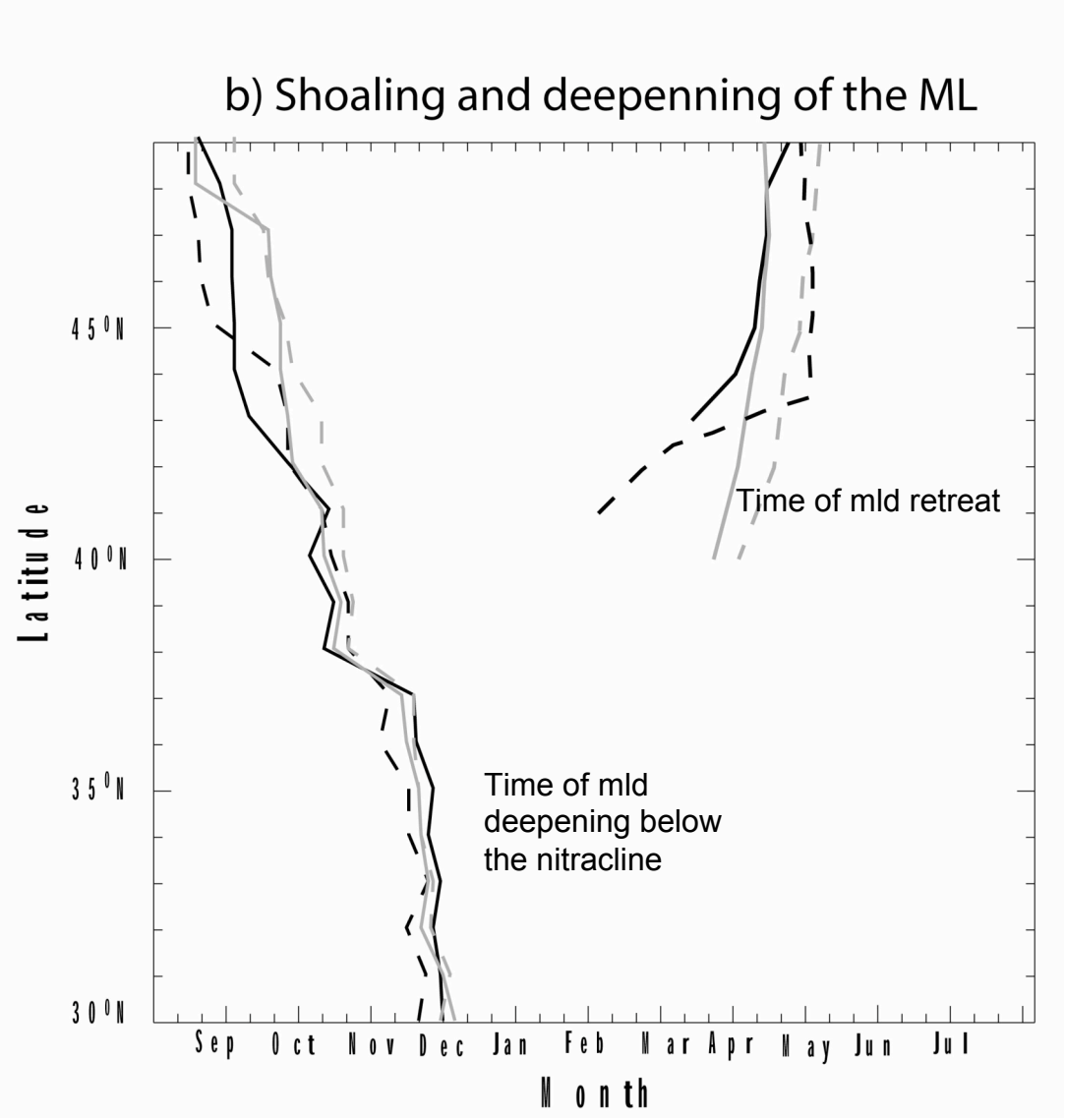
30N

Interannual variability

- Regime boundaries
- Bloom intensity
- Bloom timing (propagation)

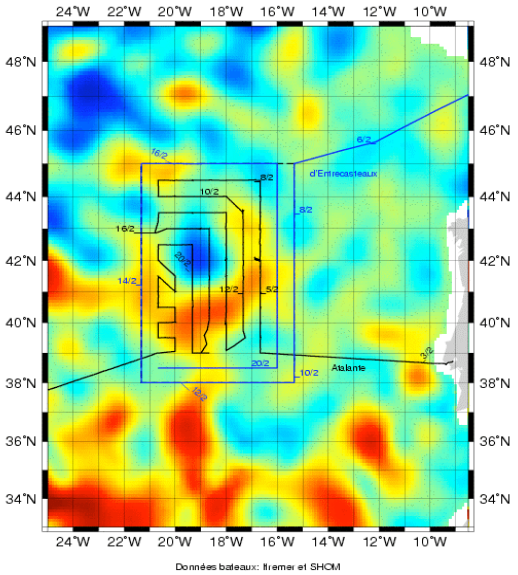
Bloom propagations



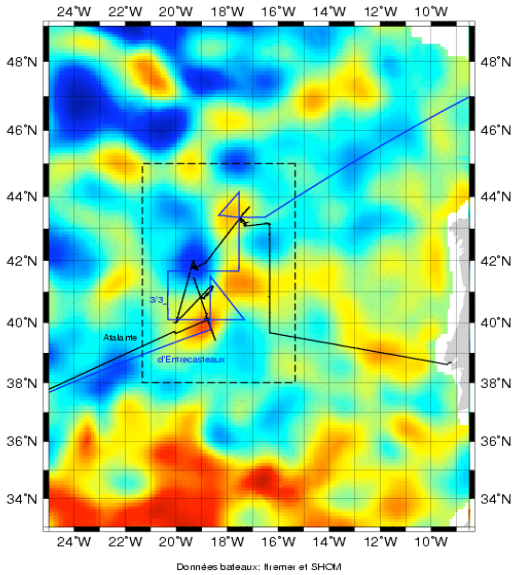


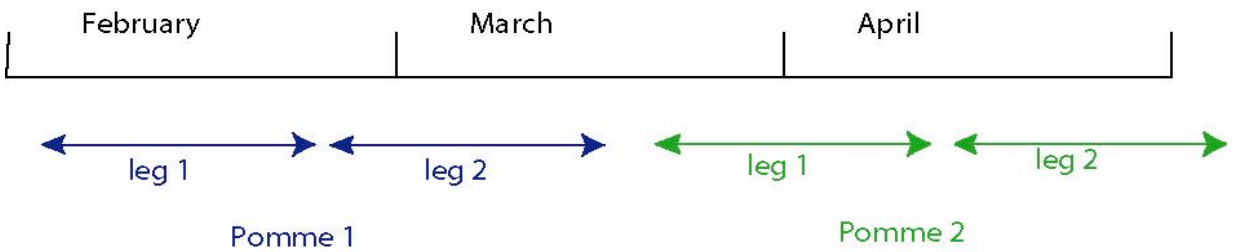
POMME observational strategy : mesoscale surveys

Leg1



Leg2

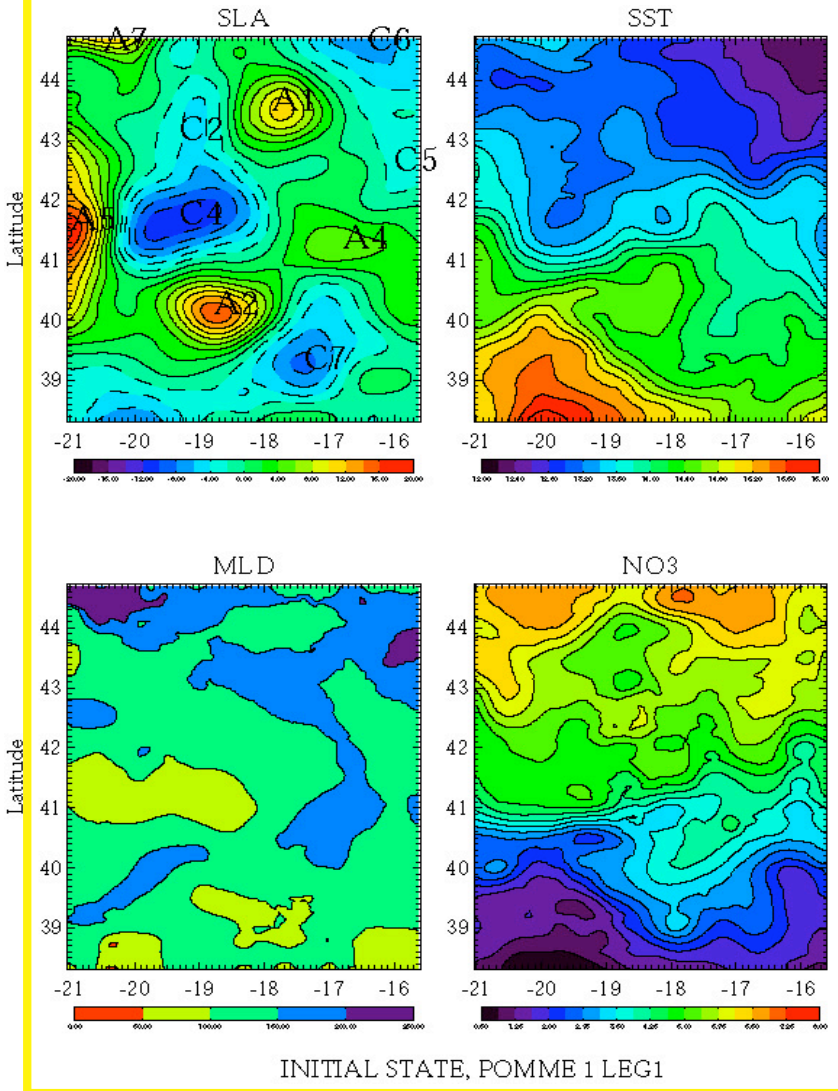




- Legs 1 : mesoscale surveys CTD - 50 km, 3 weeks
- Legs 2 : 4 stations located in specific eddies or at their border were visited intensively for a couple days (longer biological experiments)
- Advantage : both large scale and mesoscale characteristics
- Problems : asynopticity + resolution

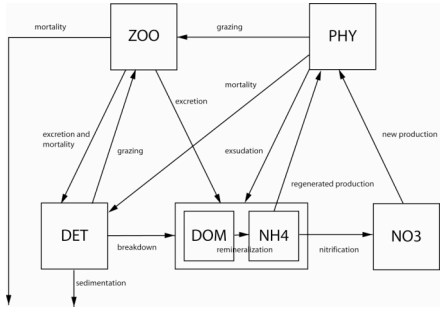
POMME: Model study

Initial conditions



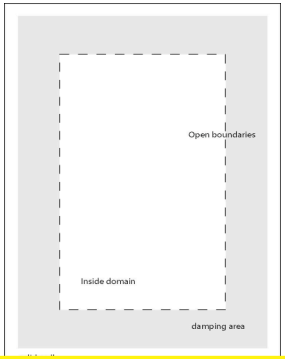
INITIAL STATE, POMME 1 LEG1

Biogeochemical model



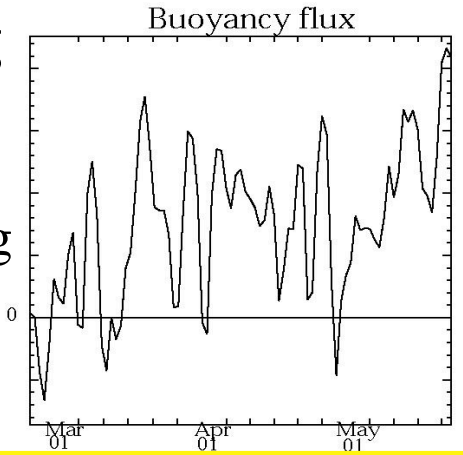
Physical model

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

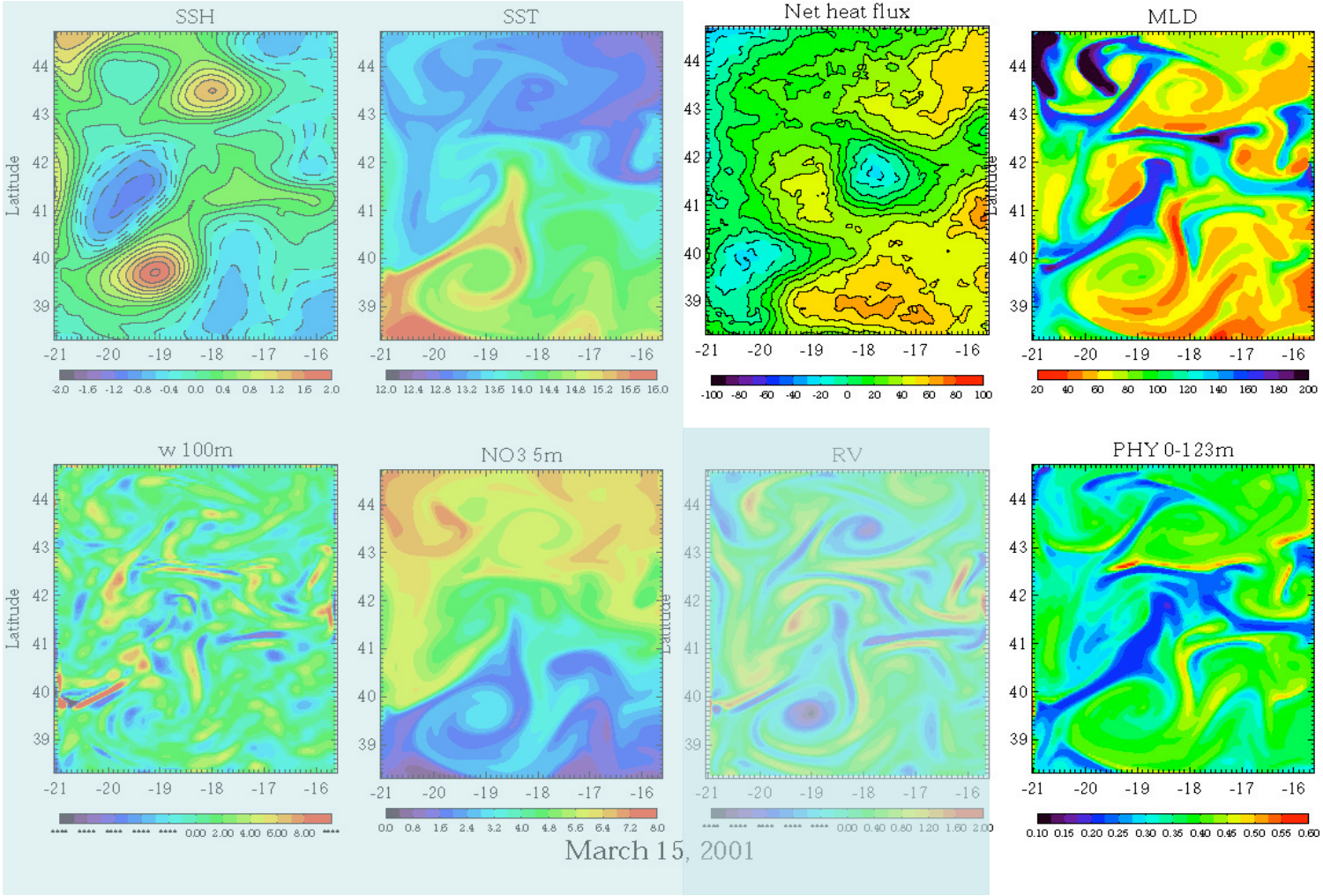


Atmospheric forcing

- from shipboard +satellite
- Mean : Seasonal warming
- Strong intermittency



Early bloom

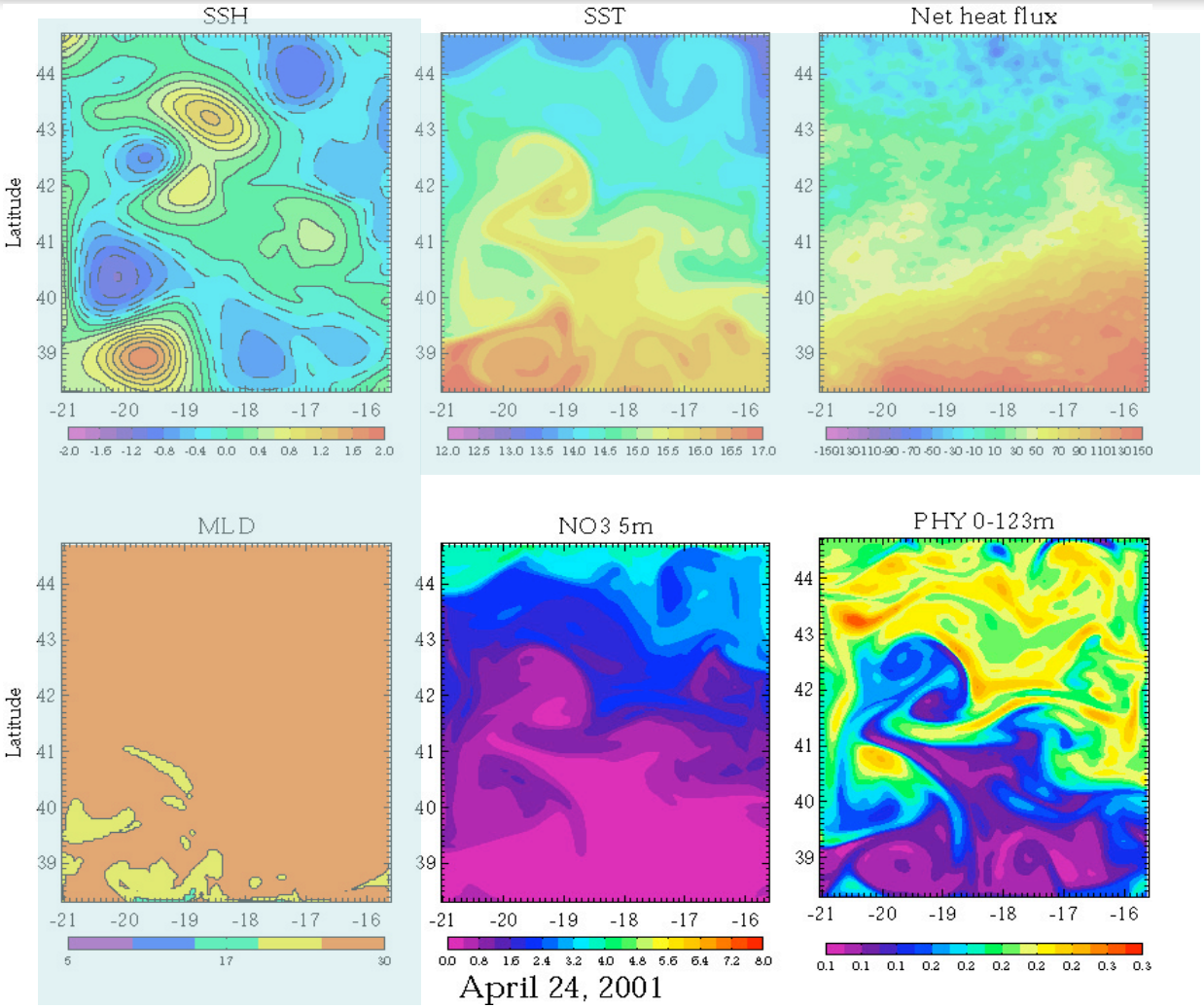


Heat flux
mesoscale forcing

Eddy stirring
MLD filaments

Light control
Phytoplankton
filaments

Late bloom



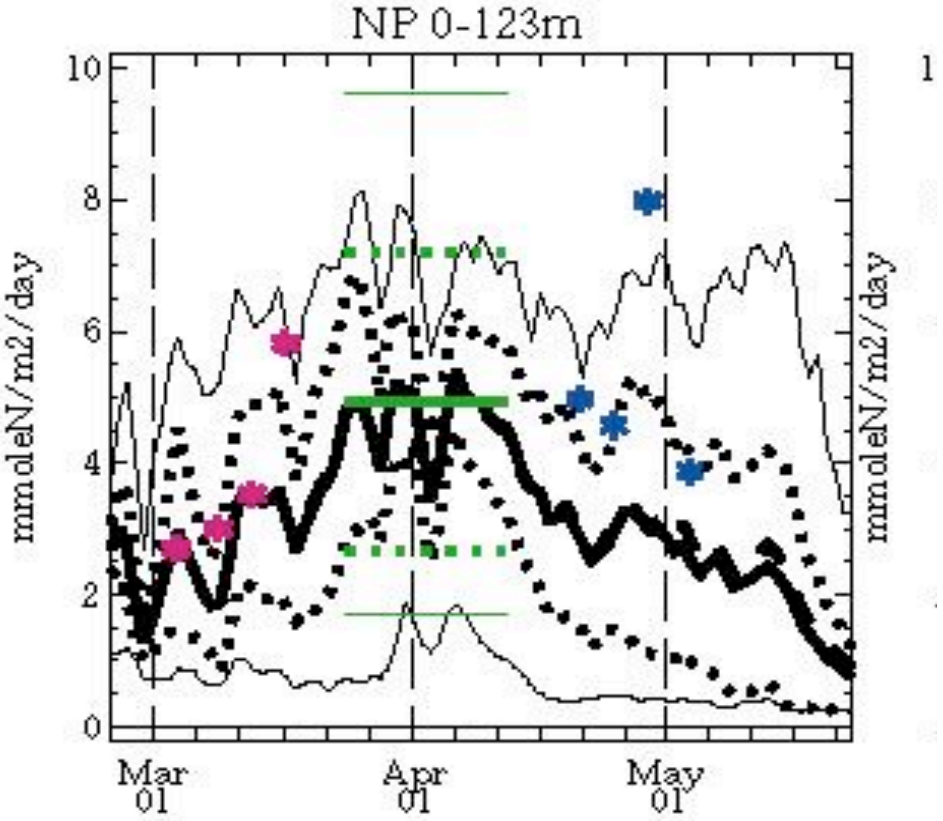
Large scale
Nutrient gradient

Eddy stirring
Horizontal mixing

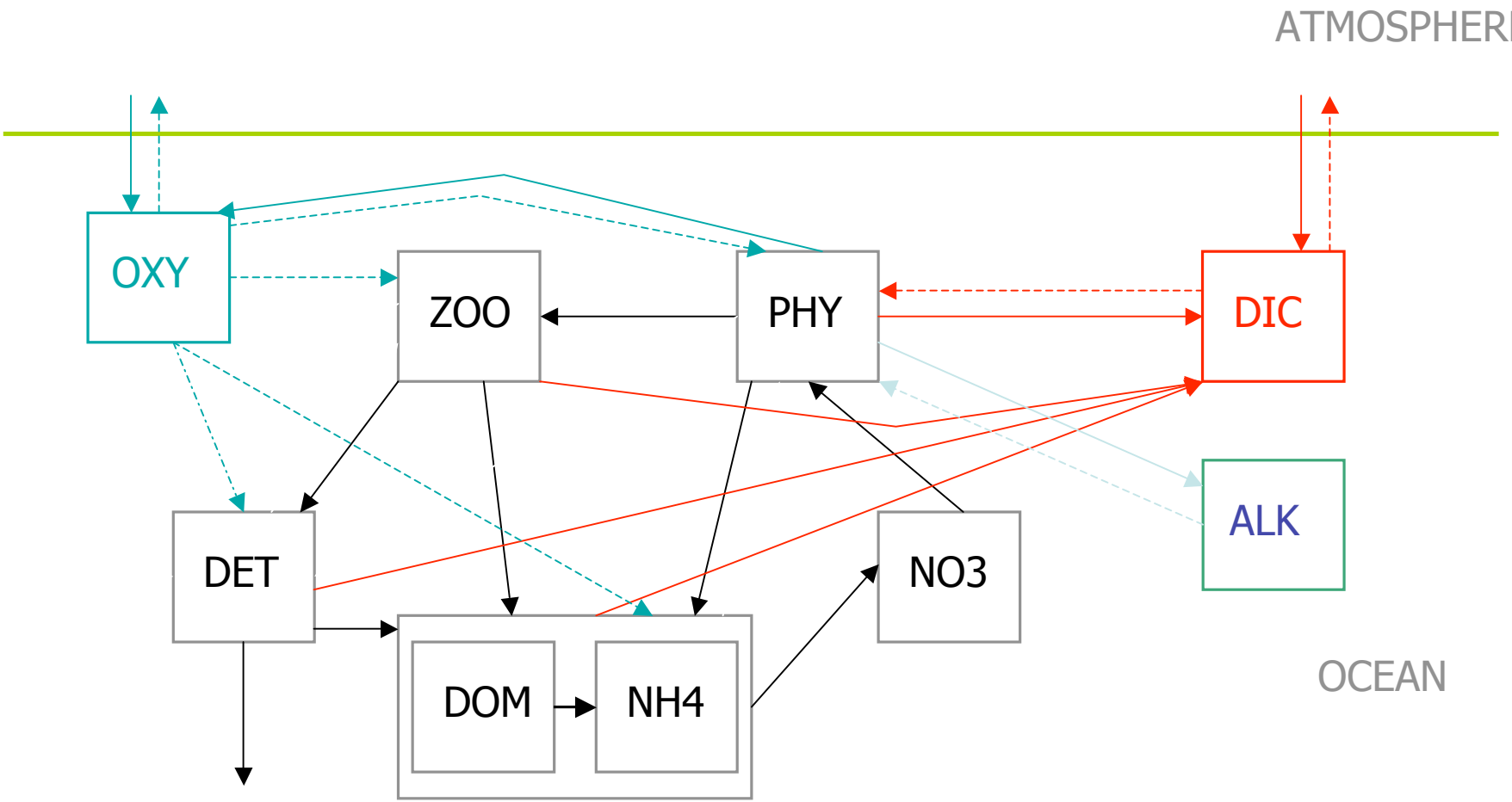
Nutrient control
Phytoplankton
filaments

Small scale / synoptic / seasonal

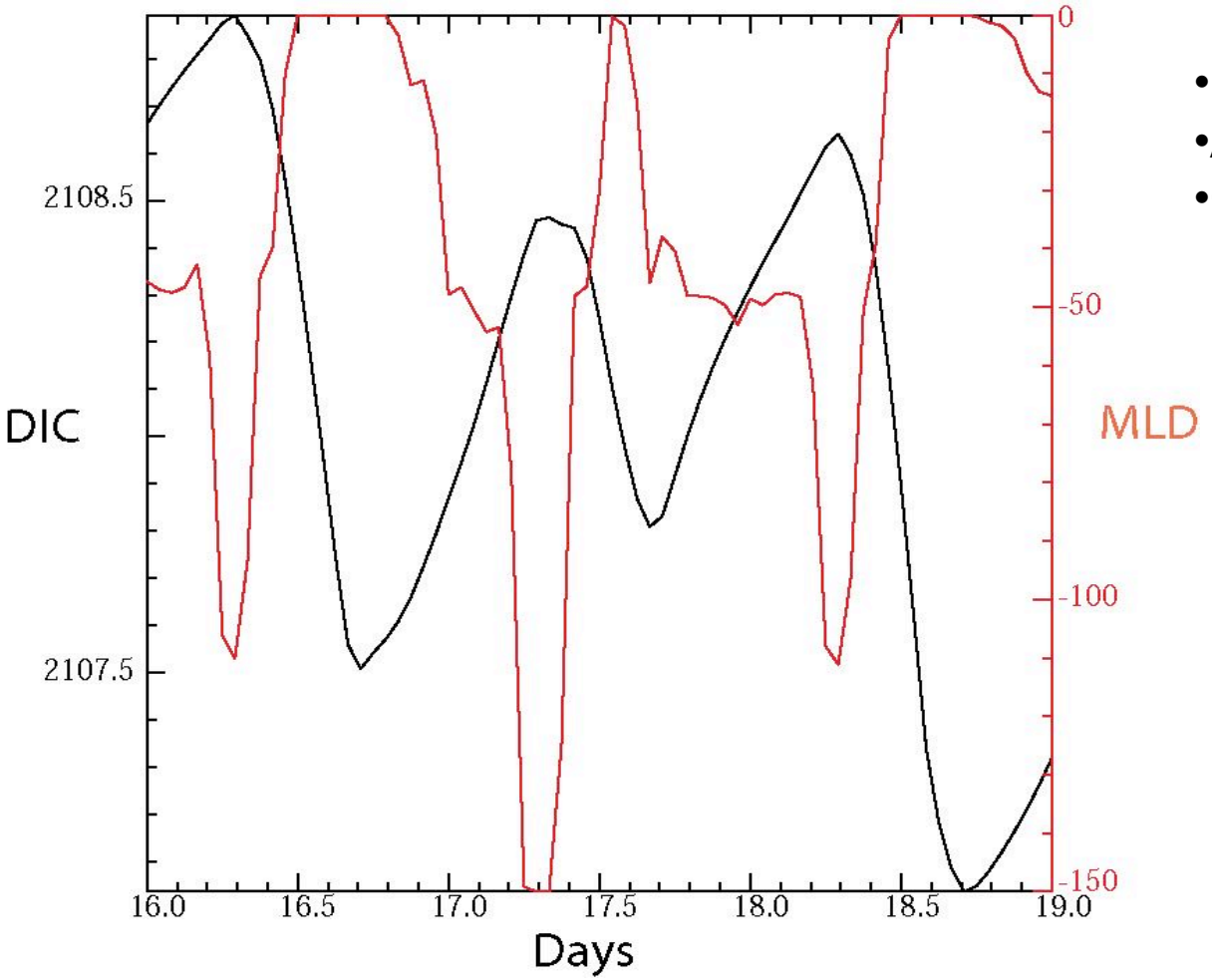
- General good agreement with data
- understimation end of April :
  absence of diurnal cycle of MLD ?
- Dominance of seasonal variations
- Impact of wind through MLD variations
- Same amplitude for small scale time and space variations



Carbon and oxygen



Diurnal cycle



- 1D lagrangian model
- Along Carioca trajectories
- Carbon cycle included

Increase of DIC at night
Consumption during day

General conclusions

Variability at all scales

- Seasonal : dominant
  - Specific regime that optimizes carbon sequestration

- Within a season : mesoscale = synoptic
  - But very different processes
  - Difficult to separate the two in the observations

- Interannual : strong – care is needed to generalize the 2001 budgets