A Numerical Investigation of Phytoplankton Blooms in the Bay of Bengal

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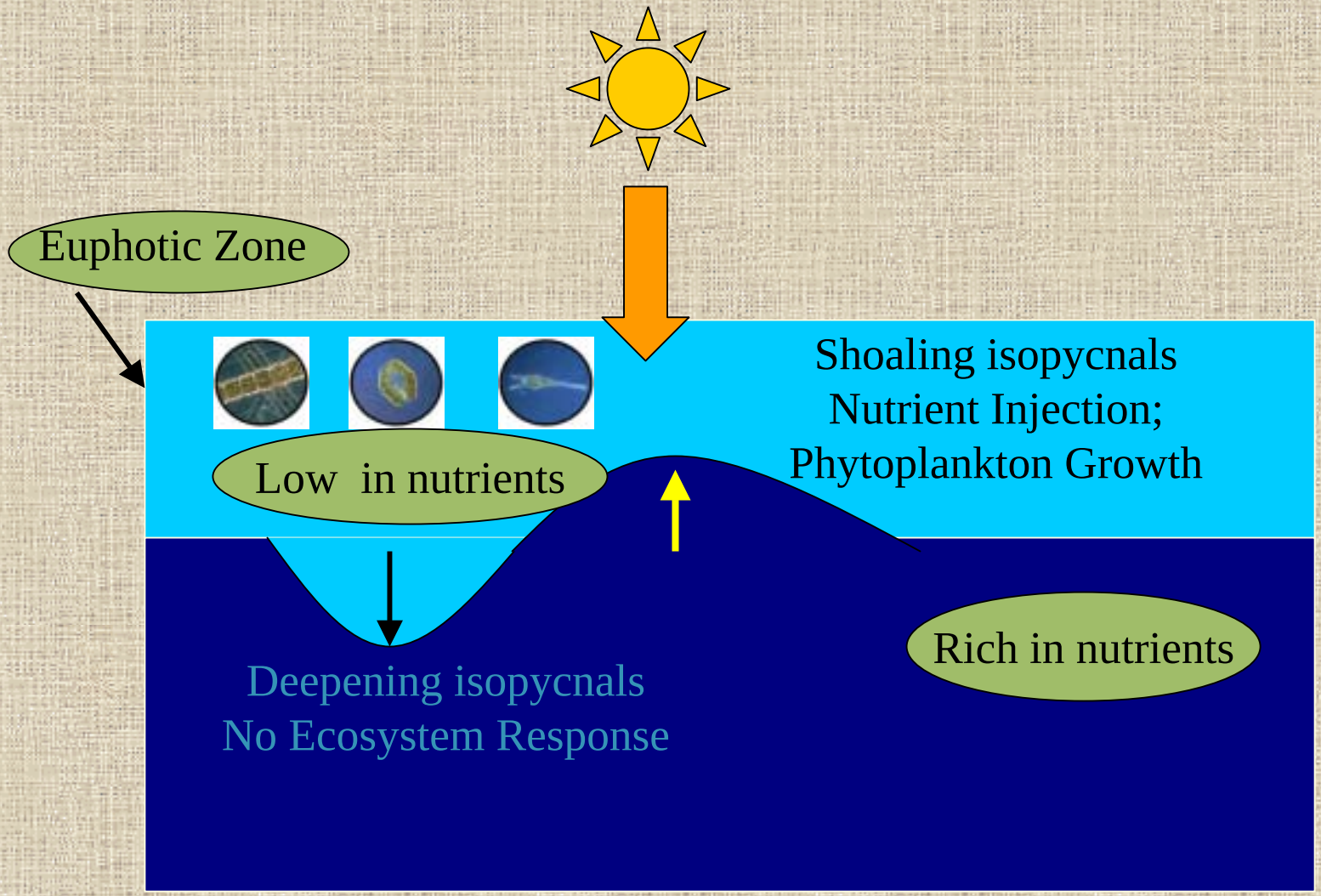
In this talk…

- **Phytoplankton and it importance**
- **Phytoplankton bloom in the Bay of Bengal**
- **Coupled Physical-Biological Model**
- **Simulation of the Bay of Bengal bloom**
- **Processes**
- **Conclusions**

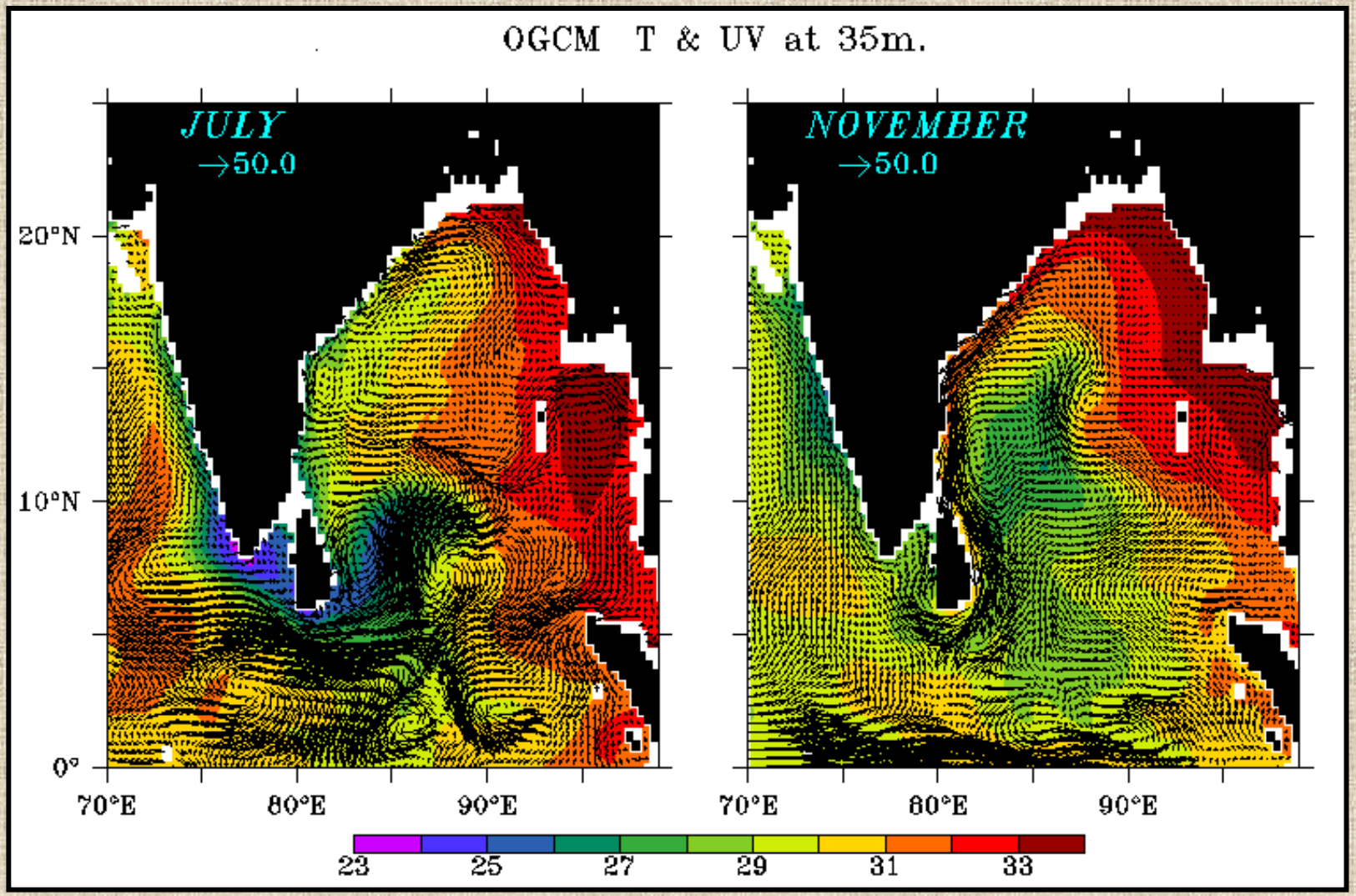
Physical-Biological Interactions



Phytoplankton Bloom in the Bay of Bengal

Thermal Domes in the Bay of Bengal

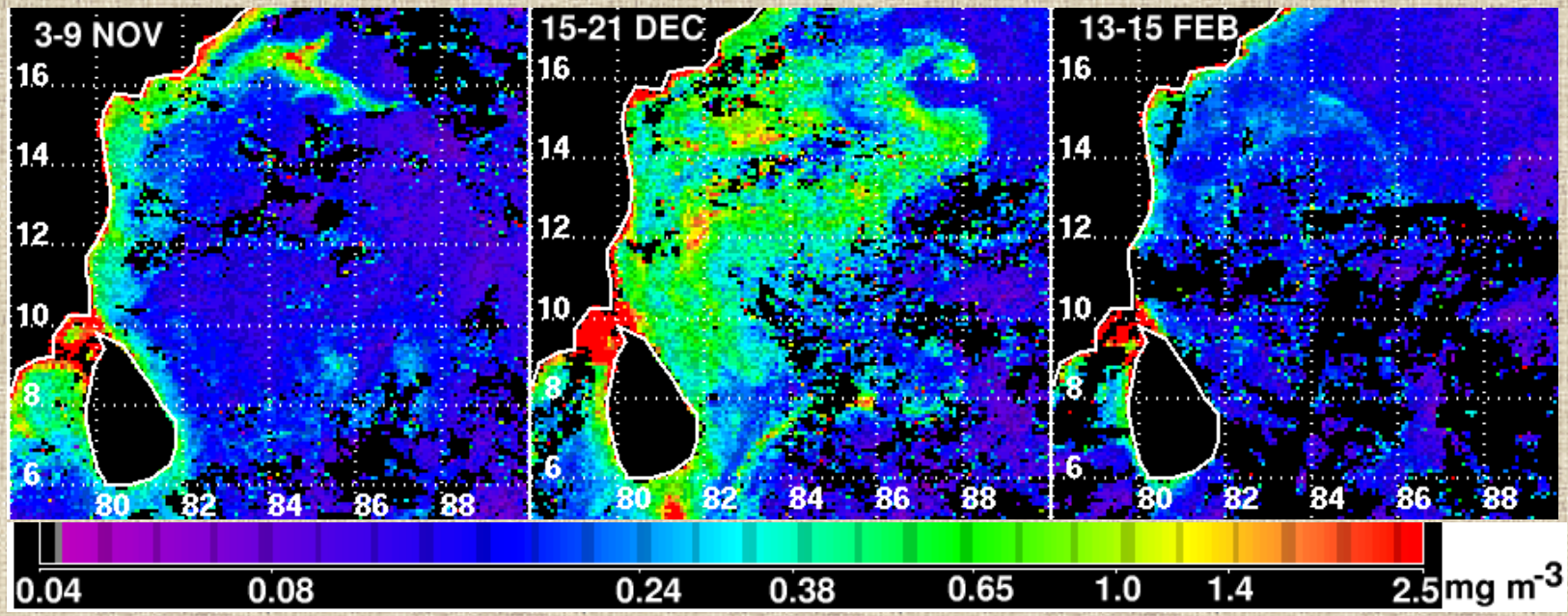
Sri Lanka Dome : Summer Monsoon **Bay of Bengal Dome : Winter Monsoon**



(Vinayachandran & Yamagata, JPO, 1998)

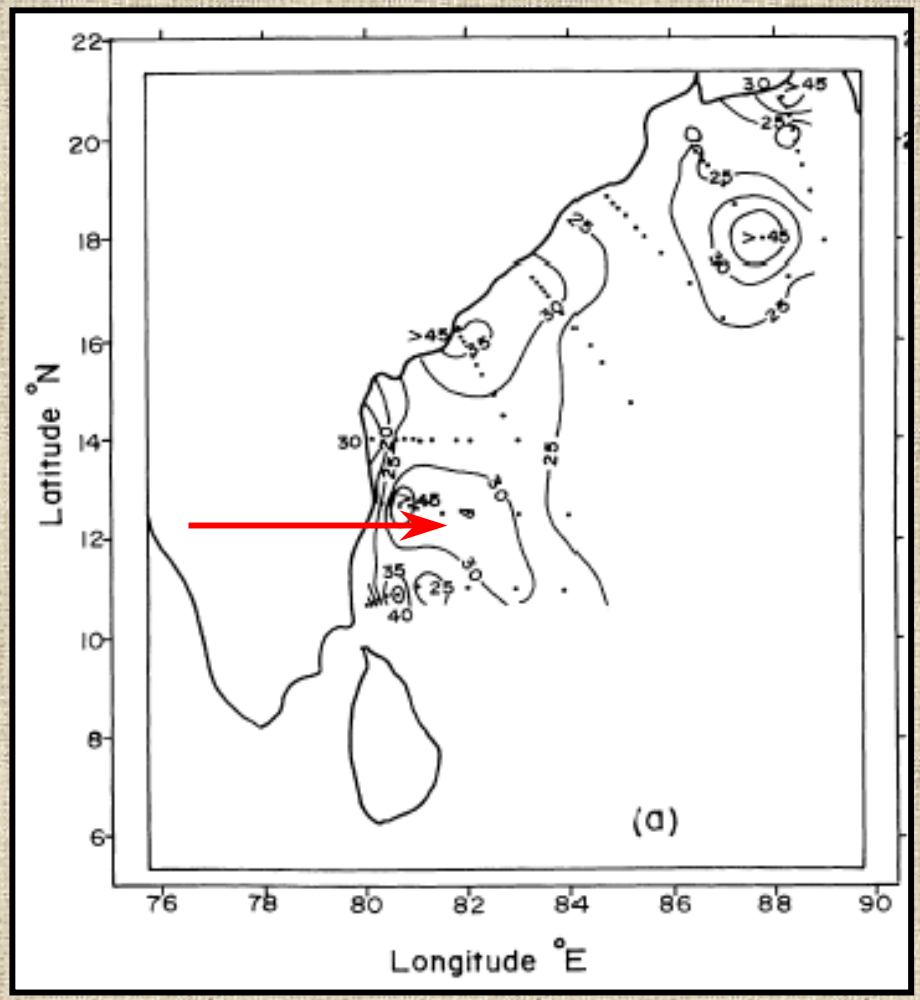
Northeast Monsoon

Weekly Chl images from OCTS during 1996

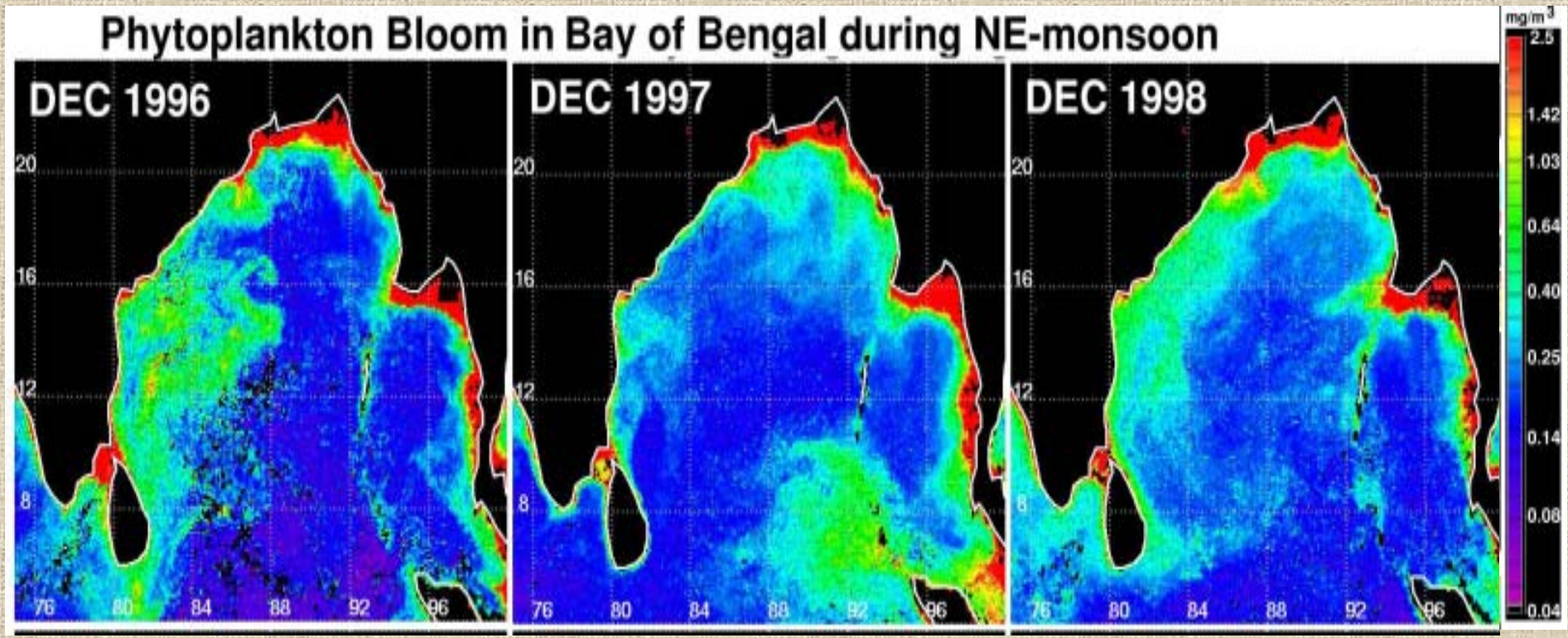


Vinayachandran and Mathew, *Geophys. Res. Lett*, 2003

Depth integrated Chl during December, 1991

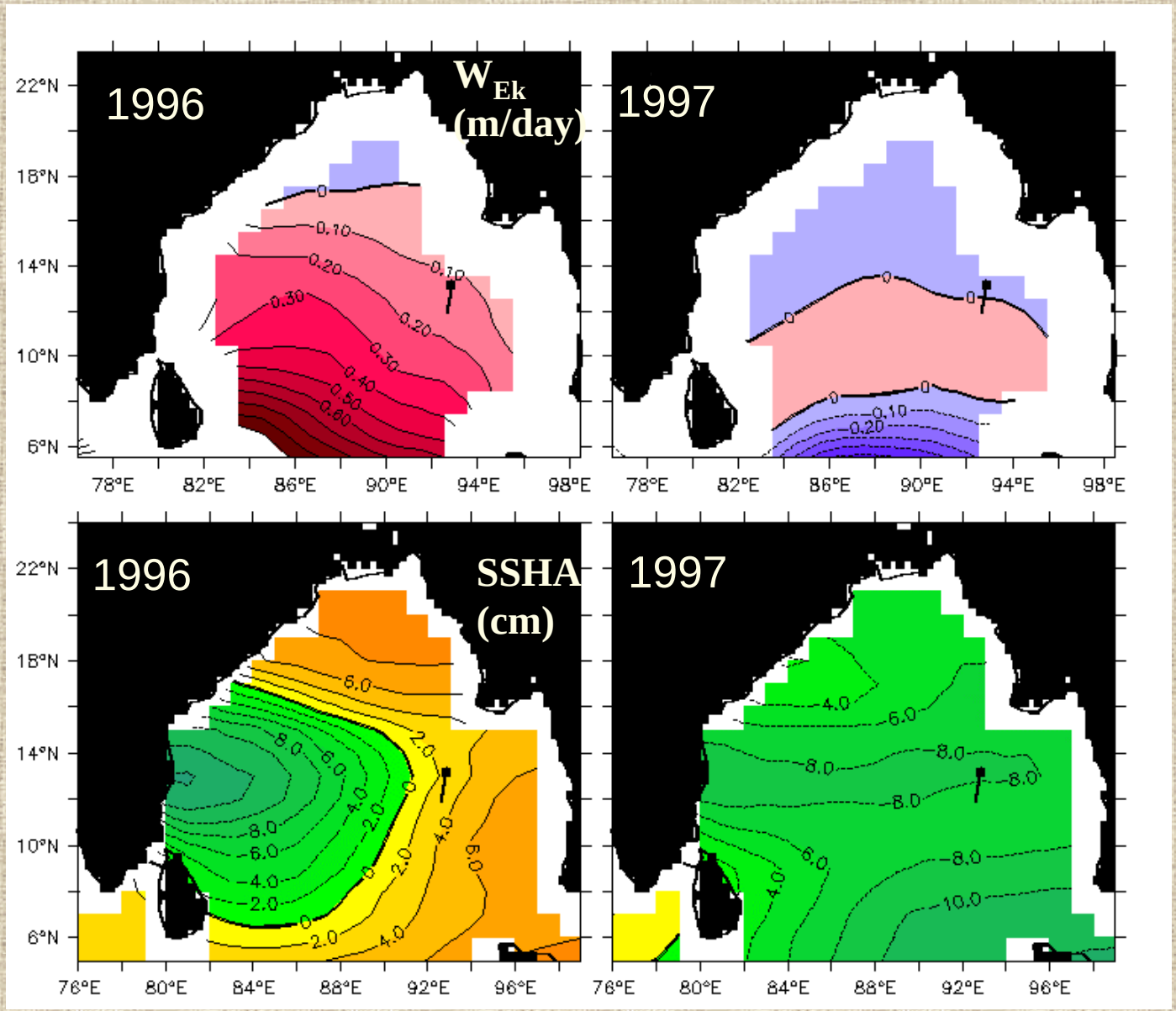


Gomes et al. 2001, Cont. Shelf Res.


Phytoplankton Bloom in Bay of Bengal during NE-monsoon
DEC 1996
DEC 1997
DEC 1998
20
16
12
8
76
80
84
88
92
96
mg/m3
2.5
1.42
1.03
0.64
0.40
0.25
0.14
0.08
0.04

Ekman Pumping (top) and SSHA (bottom)

HYPOTHESIS



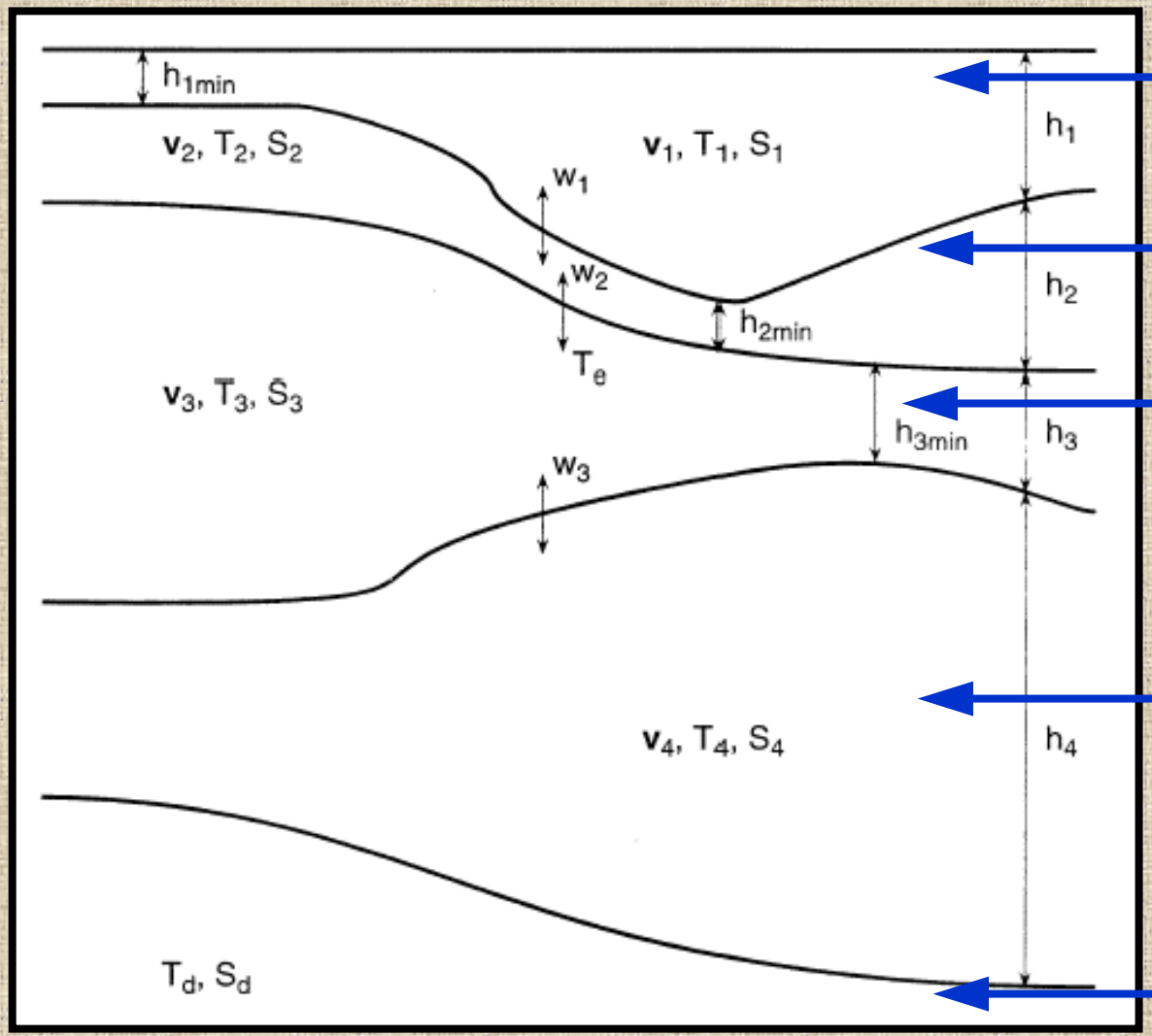
Objectives

- **Can we simulate the bloom using a numerical model ?**
- **What process causes the bloom in the model?**

The Coupled Physical - Biological Model

McCreary et al., JGR, 2001; PIO, 1996.

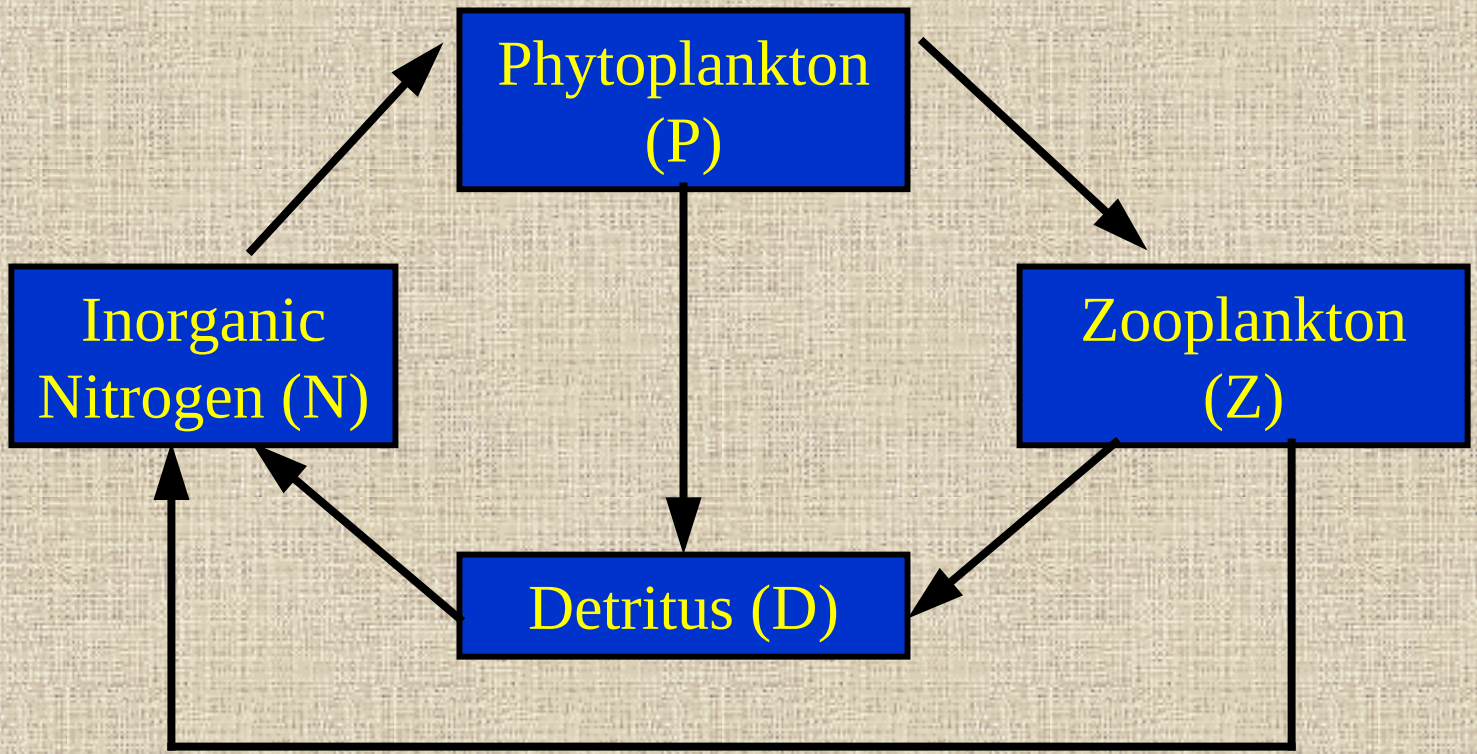
The Physical Model



Han, 1999, McCreary et al., 2001

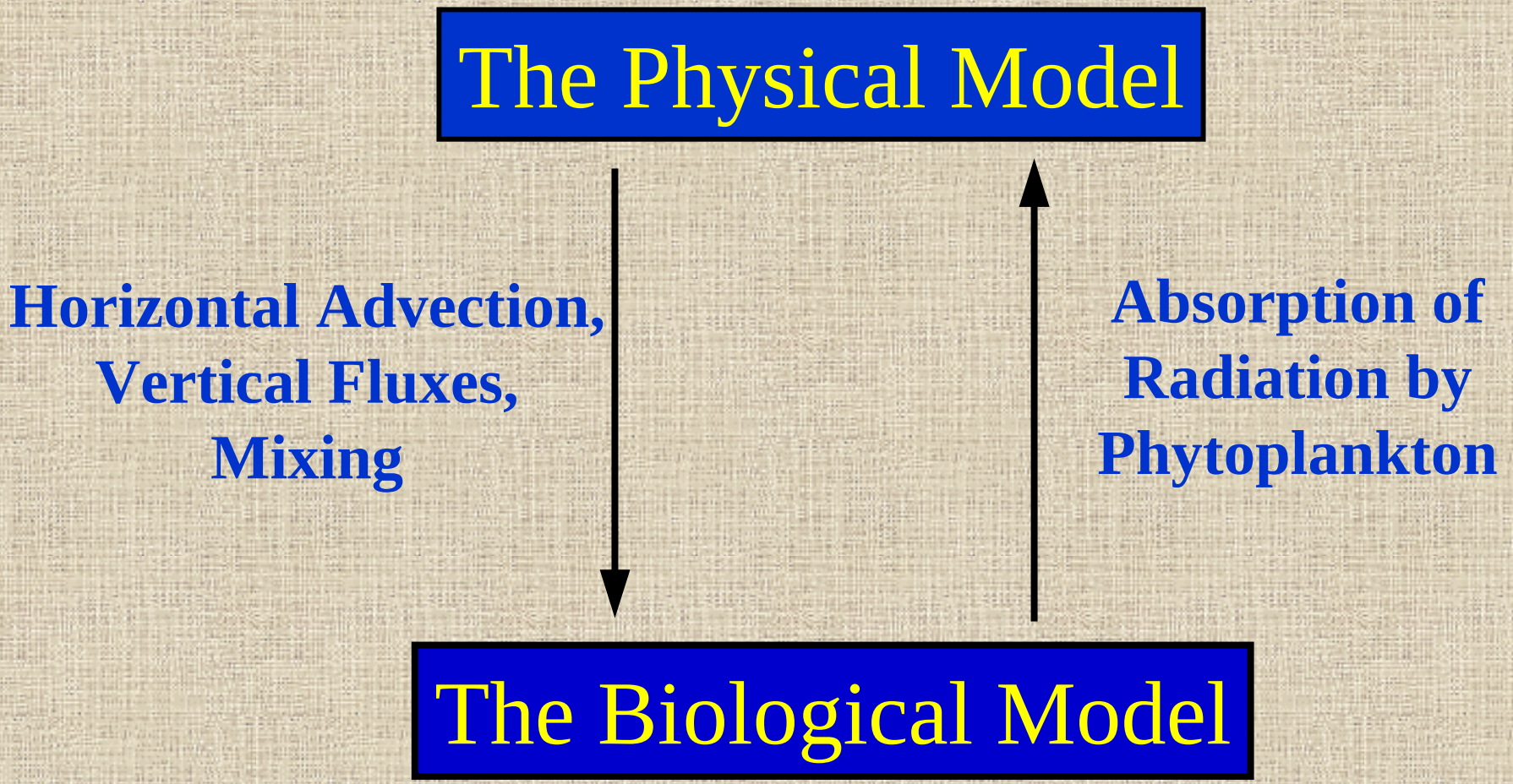
The Biological Model

Determines Nitrogen in four compartments, in 4 layers



McCreary et al., 1996, 2001

The Coupled Model



Forcing

- **Model Spin - up**

  Physical model for 5 years:

  FSU wind climatology,
  COADS climatological heat fluxes
  Legates and Willmott (1990) precipitation

  Coupled model spun-up 5 years.

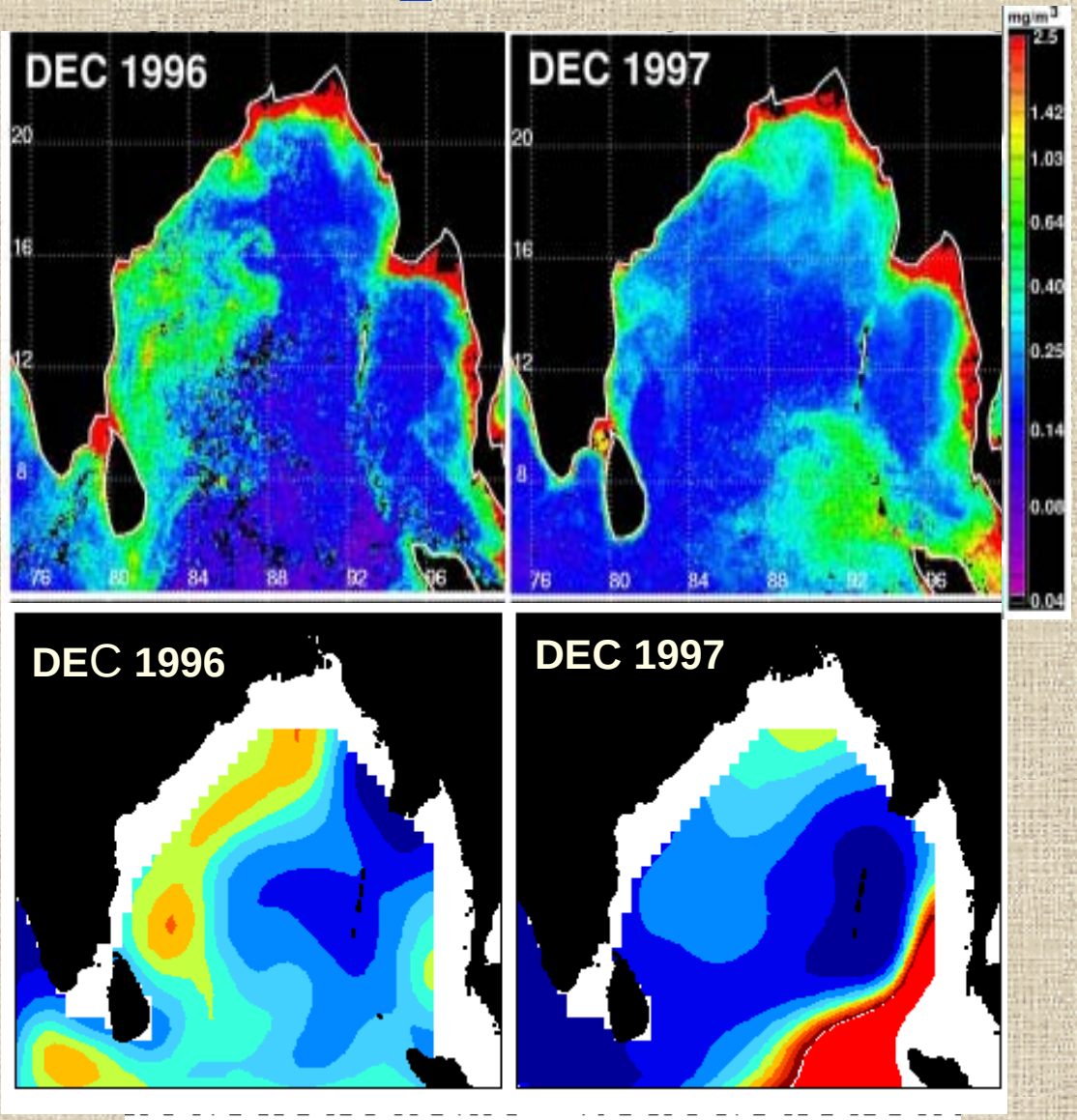
- **Coupled model run**

  April, 1996 - December, 2001
  ERA - 40 reanalyses daily winds

Comparison

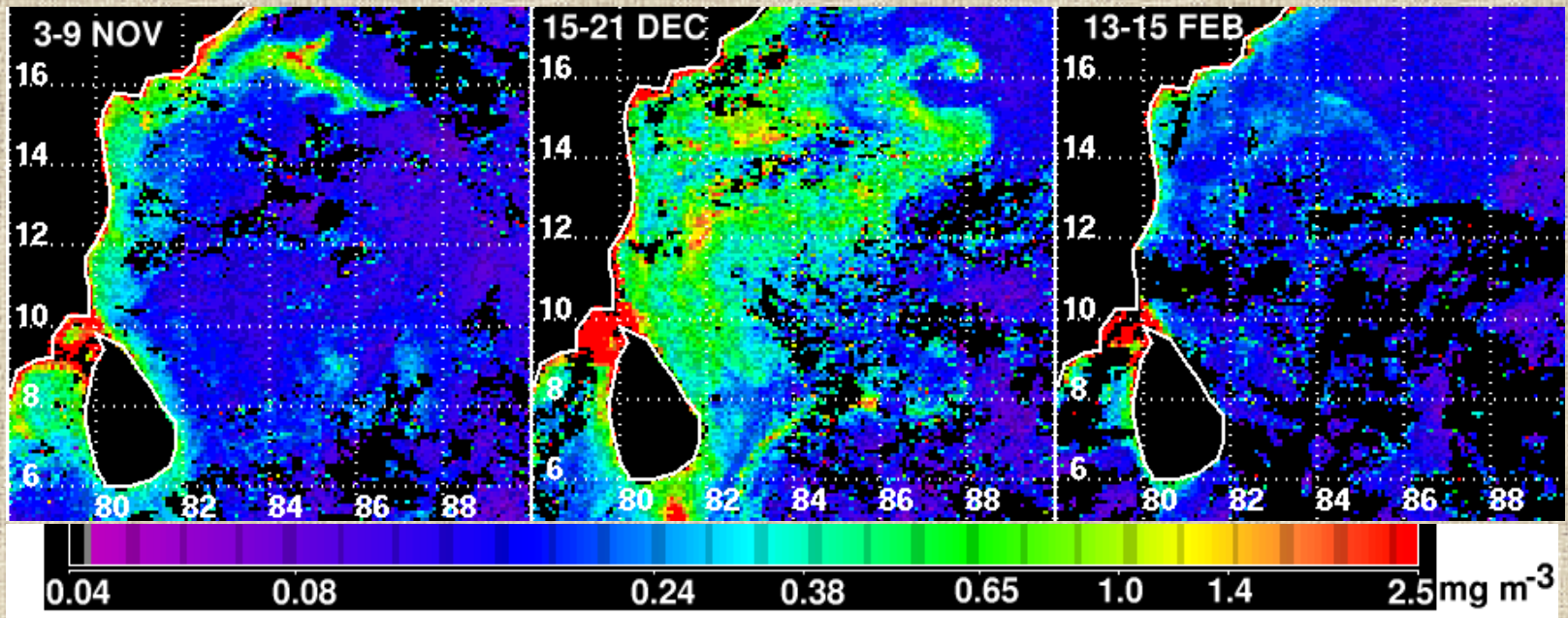
DATA

MODEL

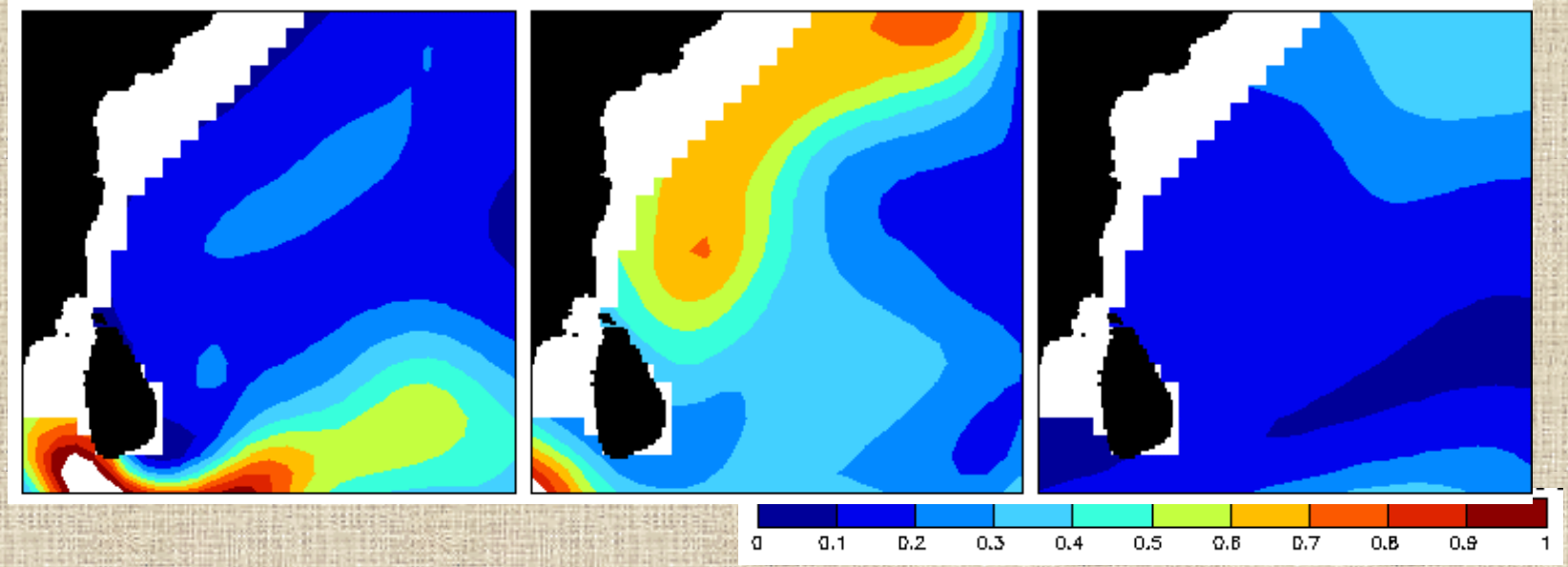


Evolution of the 1996 bloom

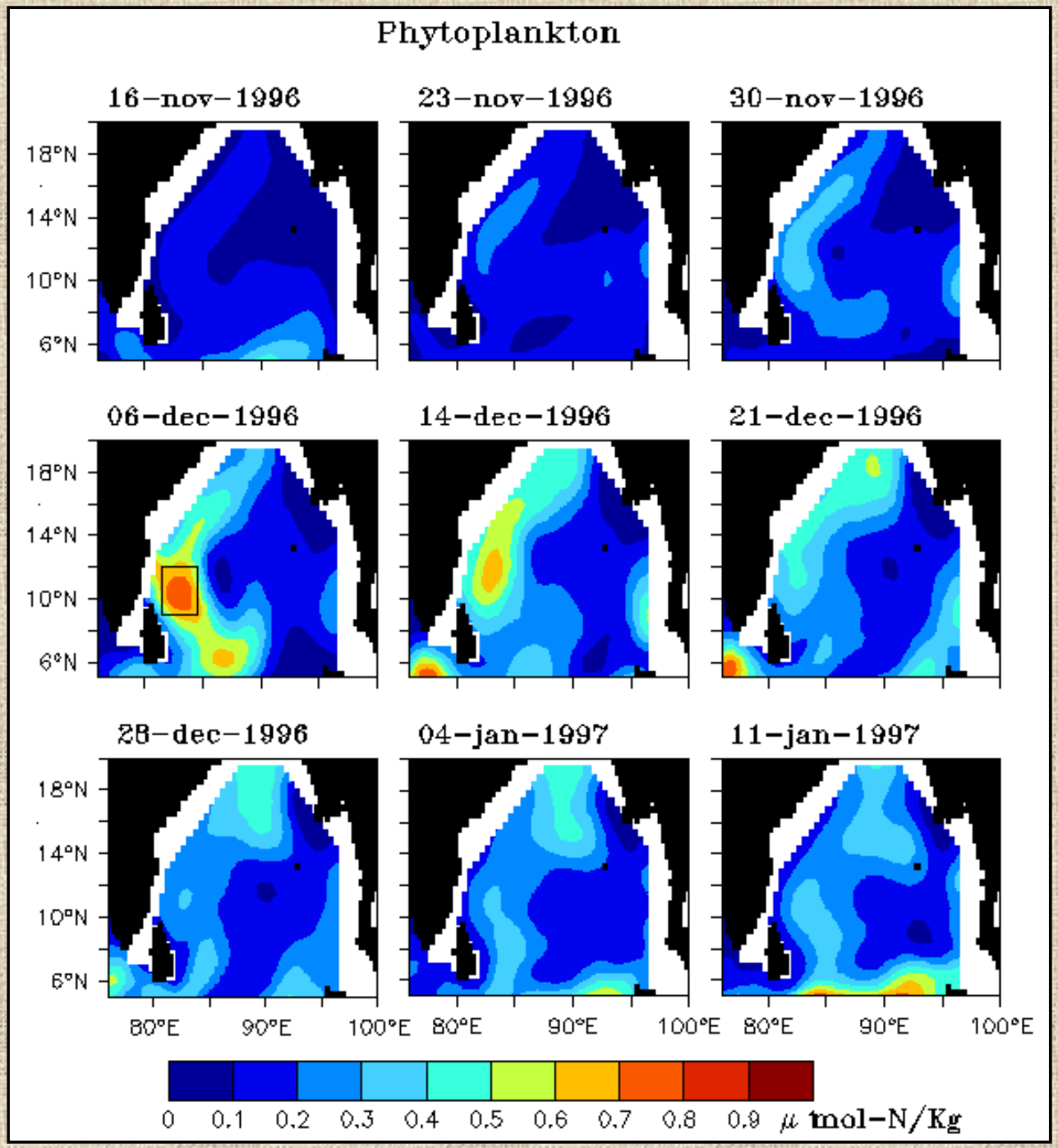
DATA



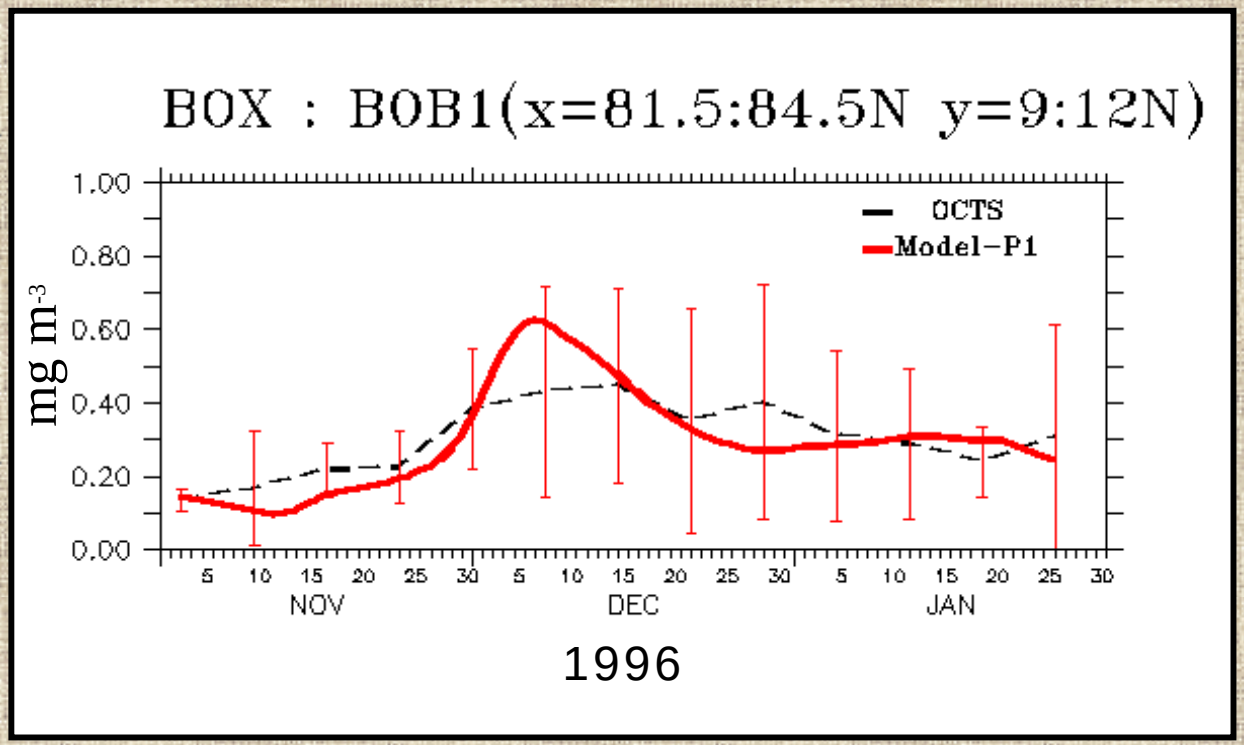
MODEL



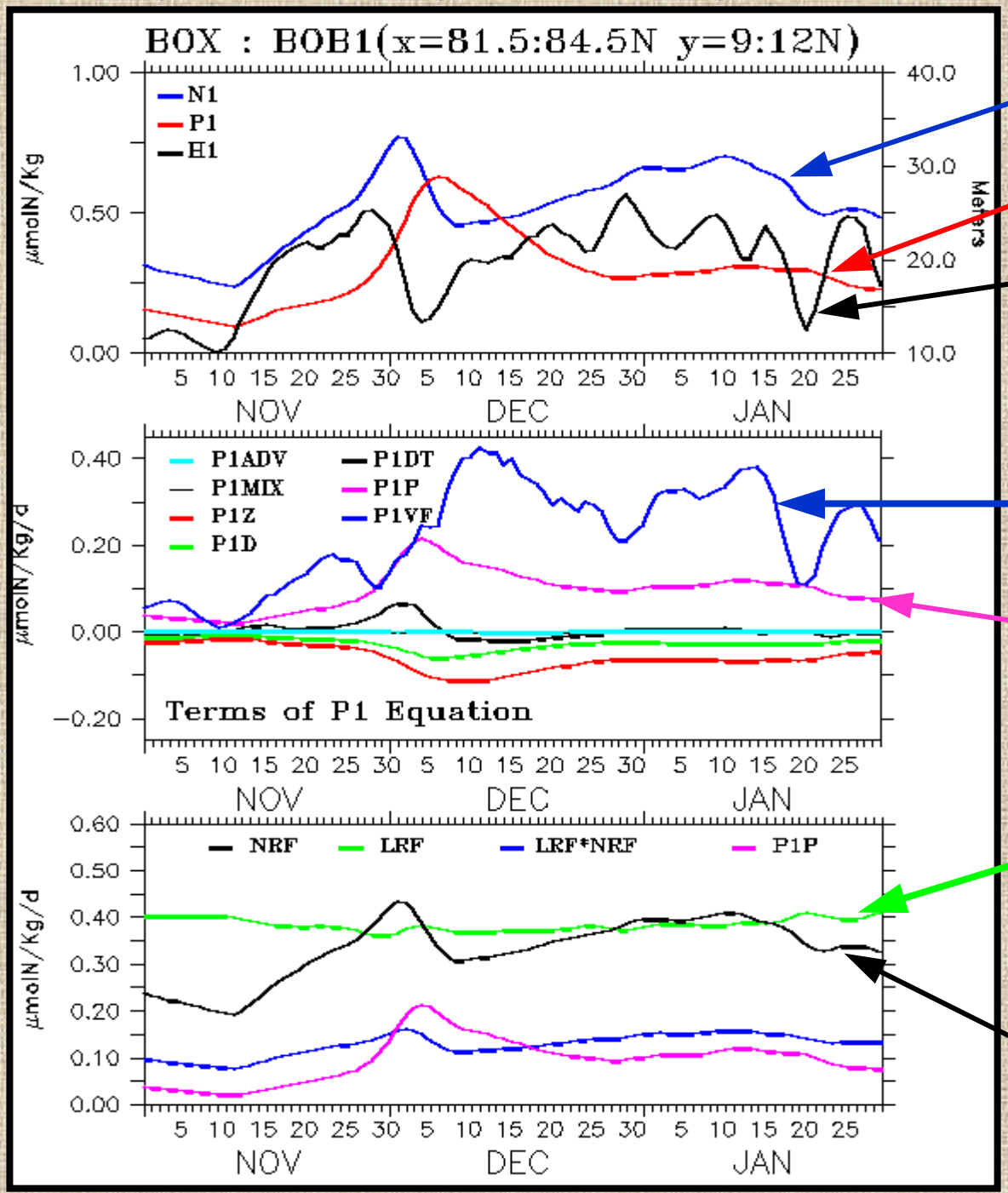
EVOLUTION


Phytoplankton
16-nov-1996
23-nov-1996
30-nov-1996
06-dec-1996
14-dec-1996
21-dec-1996
28-dec-1996
04-jan-1997
11-jan-1997
18°N
14°N
10°N
6°N
80°E
90°E
100°E
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 μ mol-N/Kg

Model – Data comparison



PROCESSES



N1

P1

H1

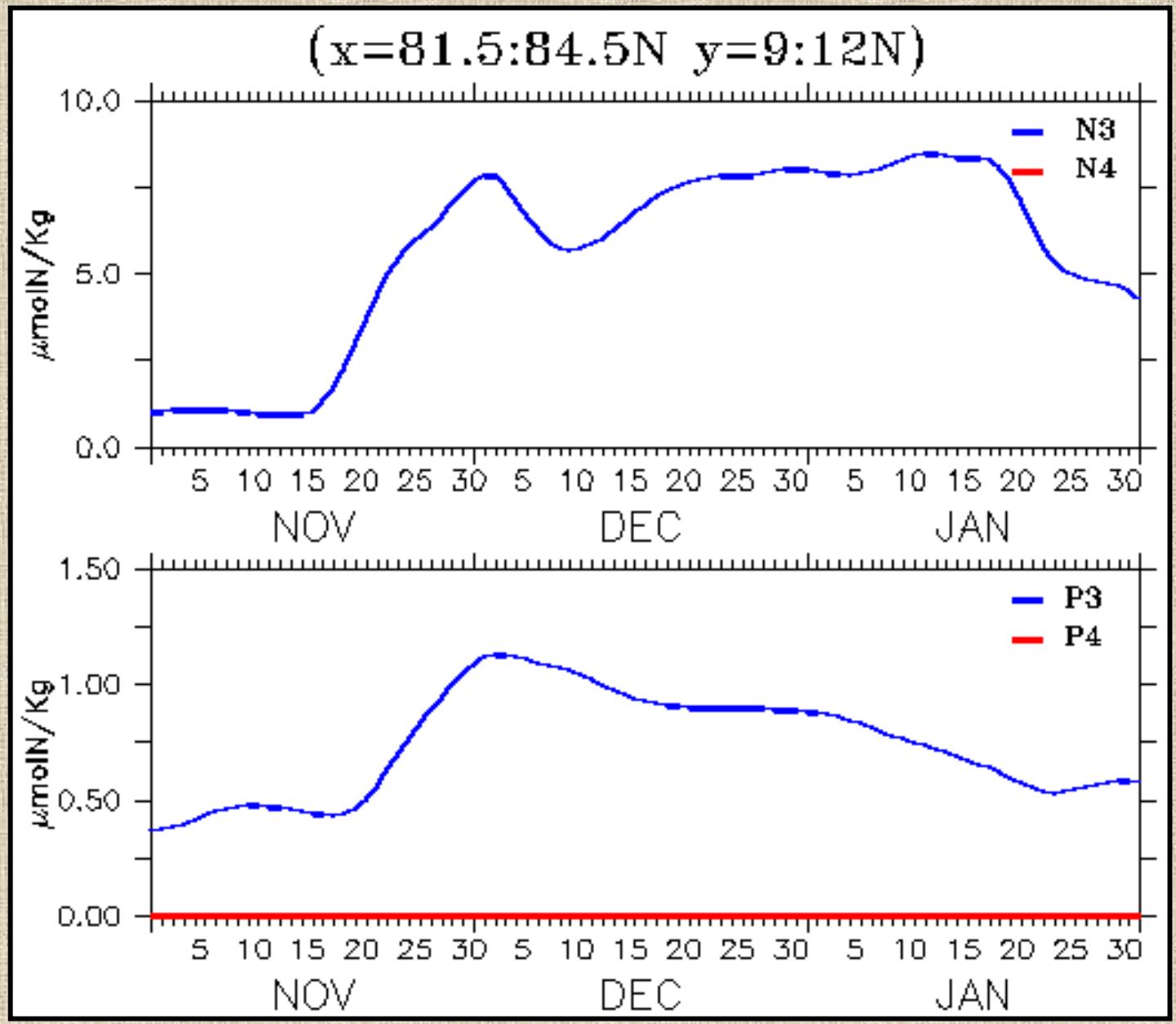
Vertical fluxes

Growth

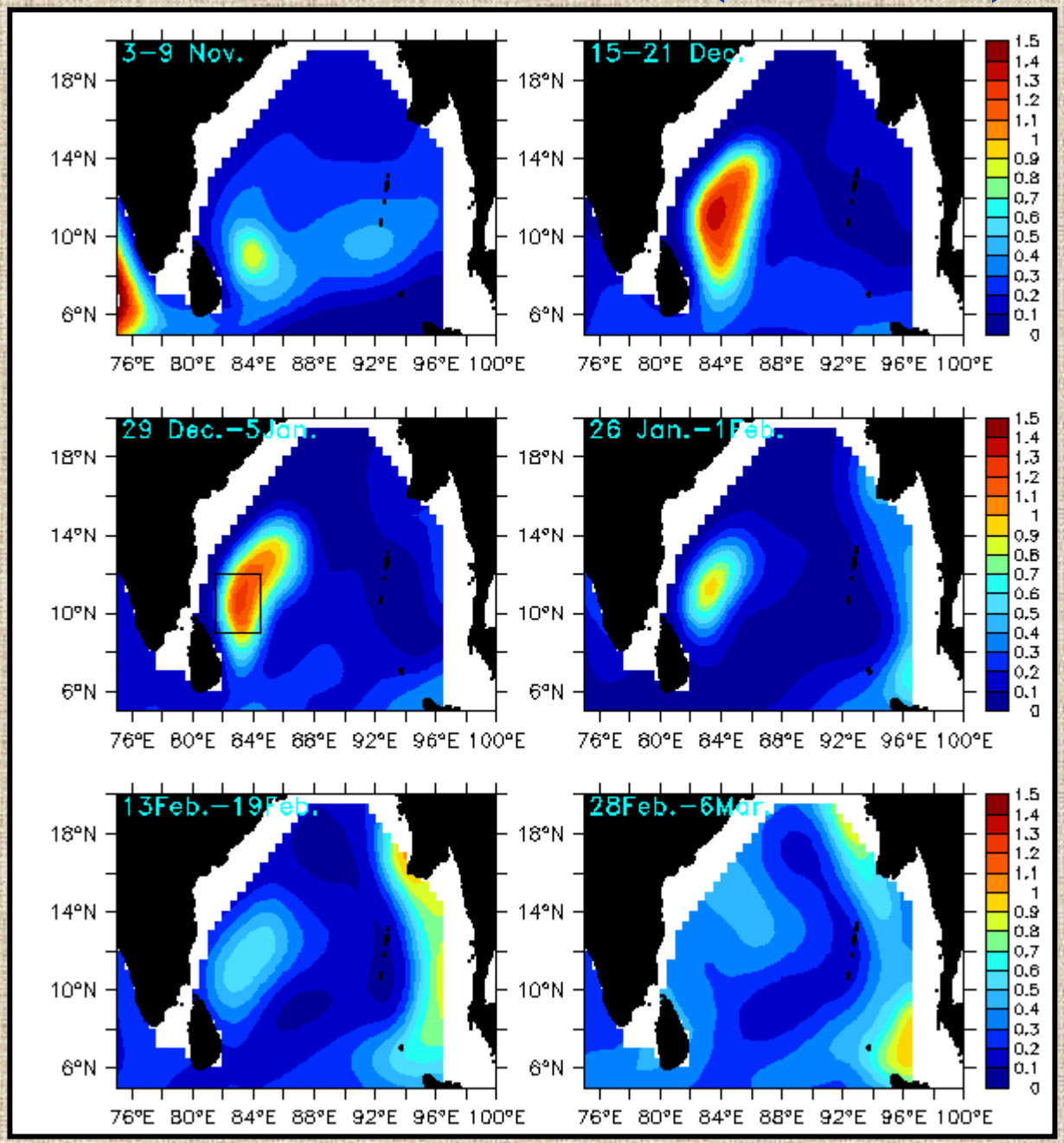
Light Response

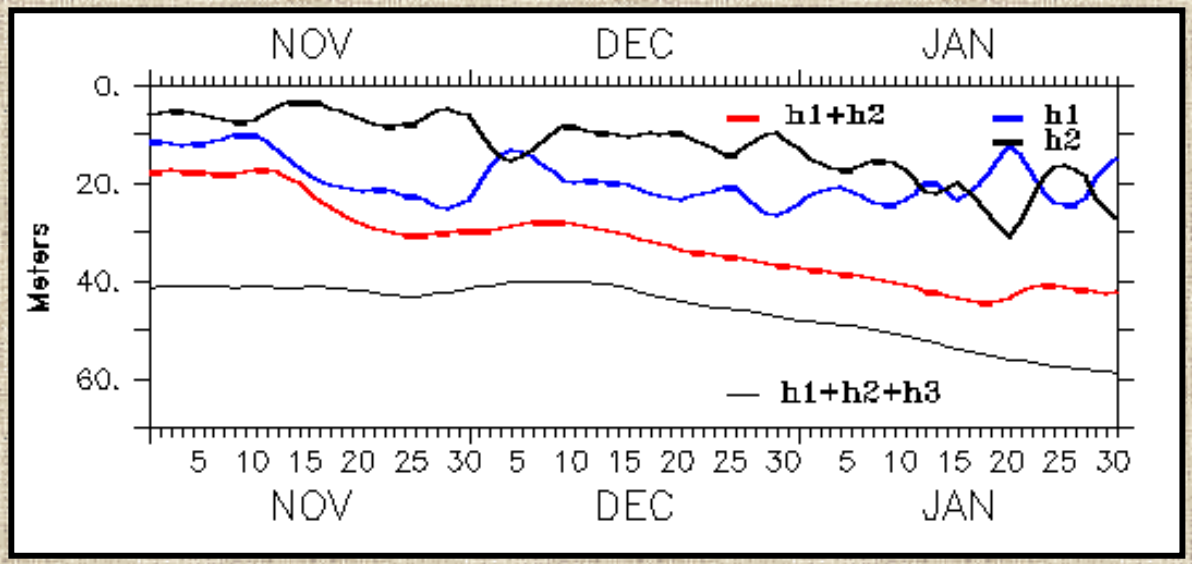
Nutrient Response

Subsurface Maximum (Model)



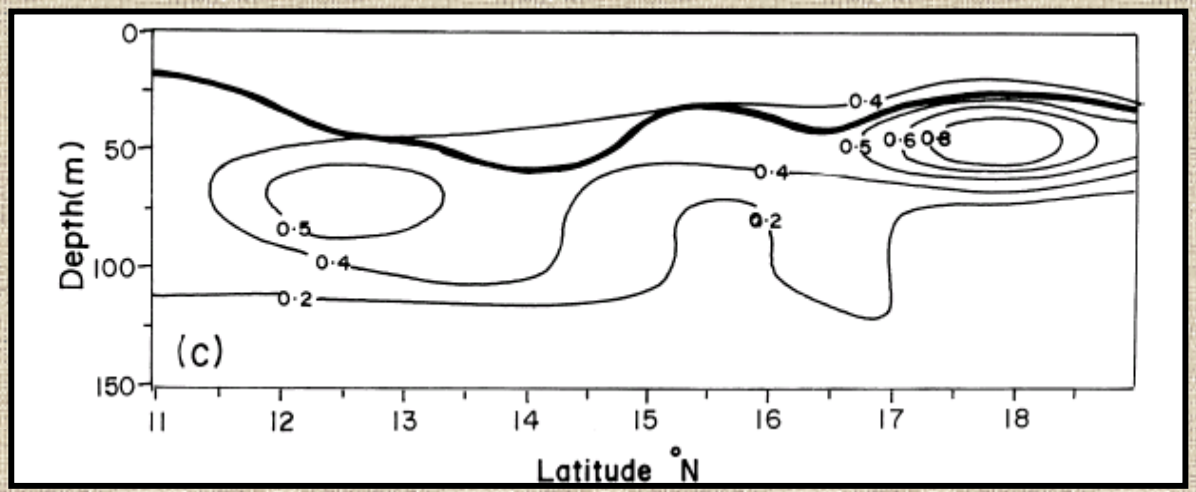
Subsurface Maximum (Model P3)





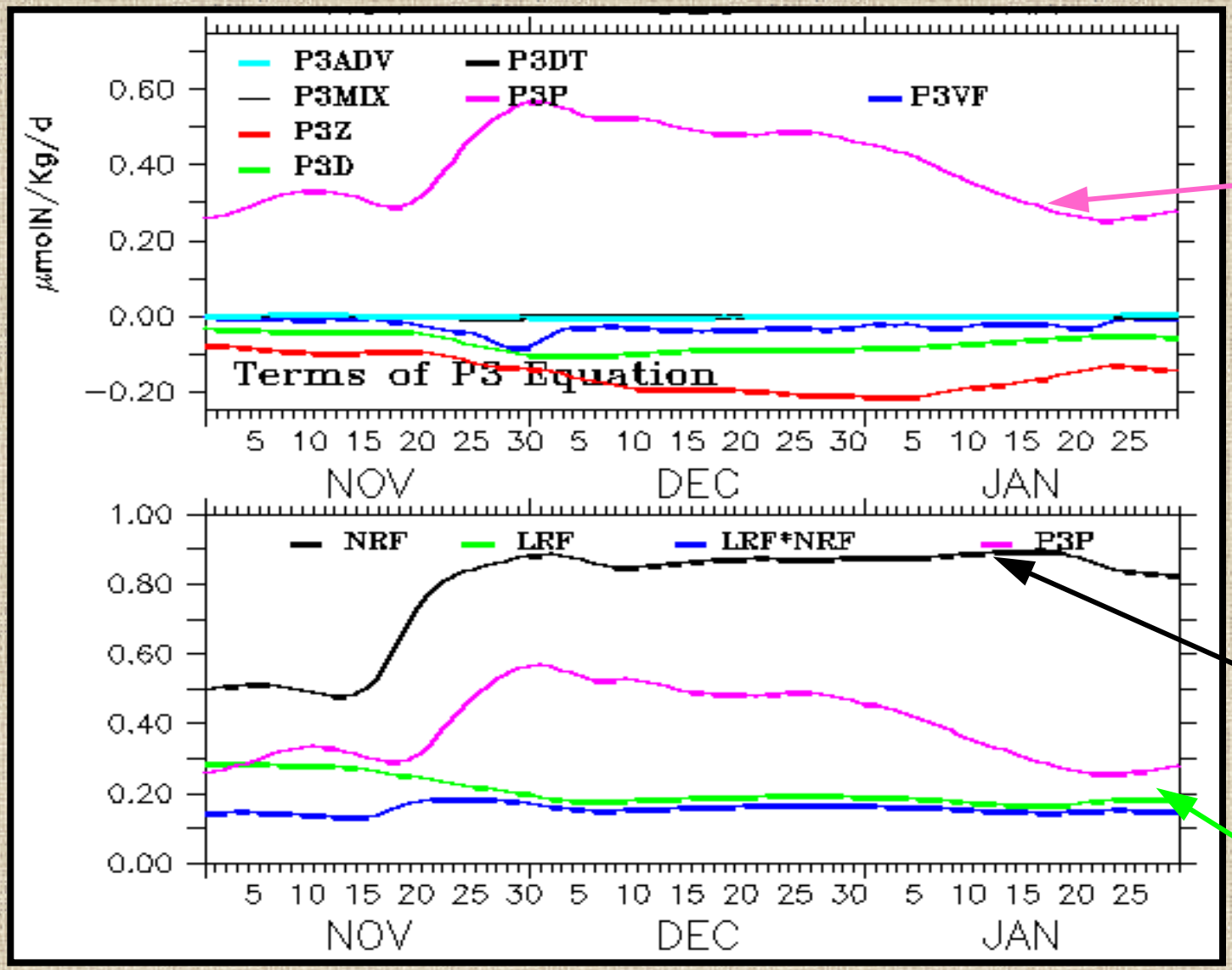
Model Layer Depths

Subsurface chl maximum (Obs., Dec., 1991)



Gomes et al., 2001, Cont. Shelf Res.

PROCESSES

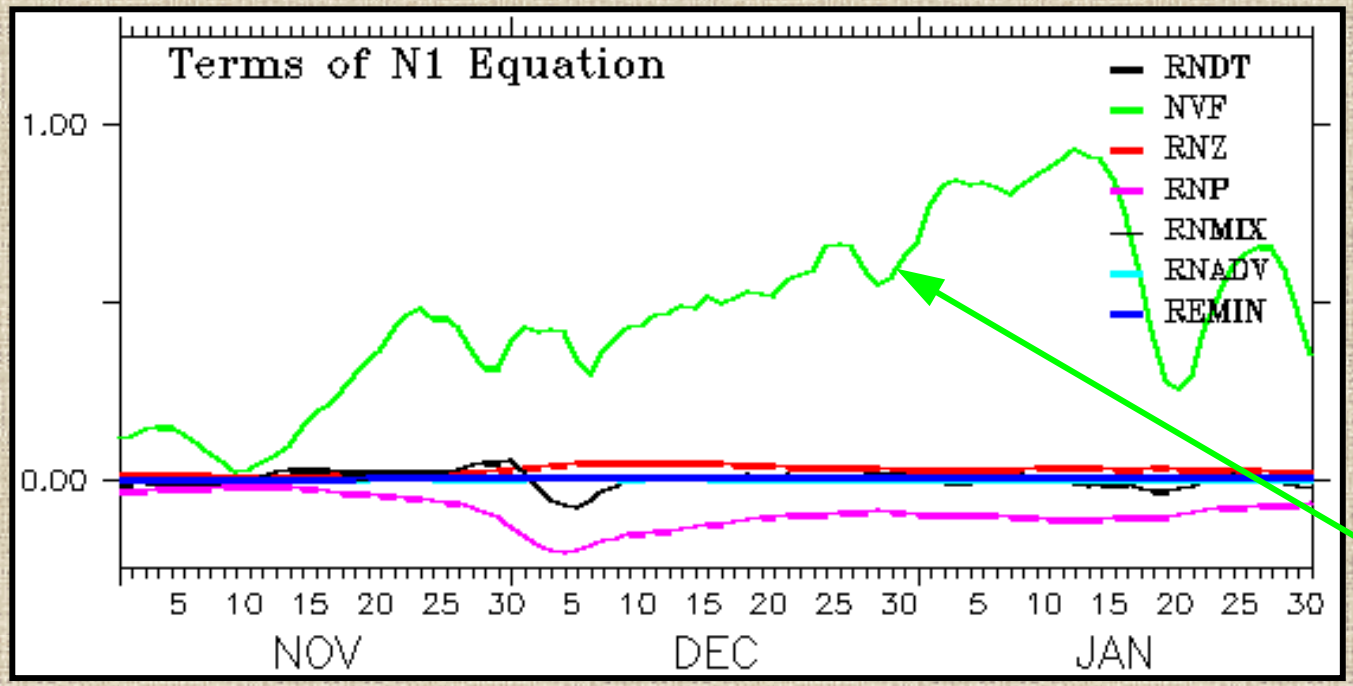


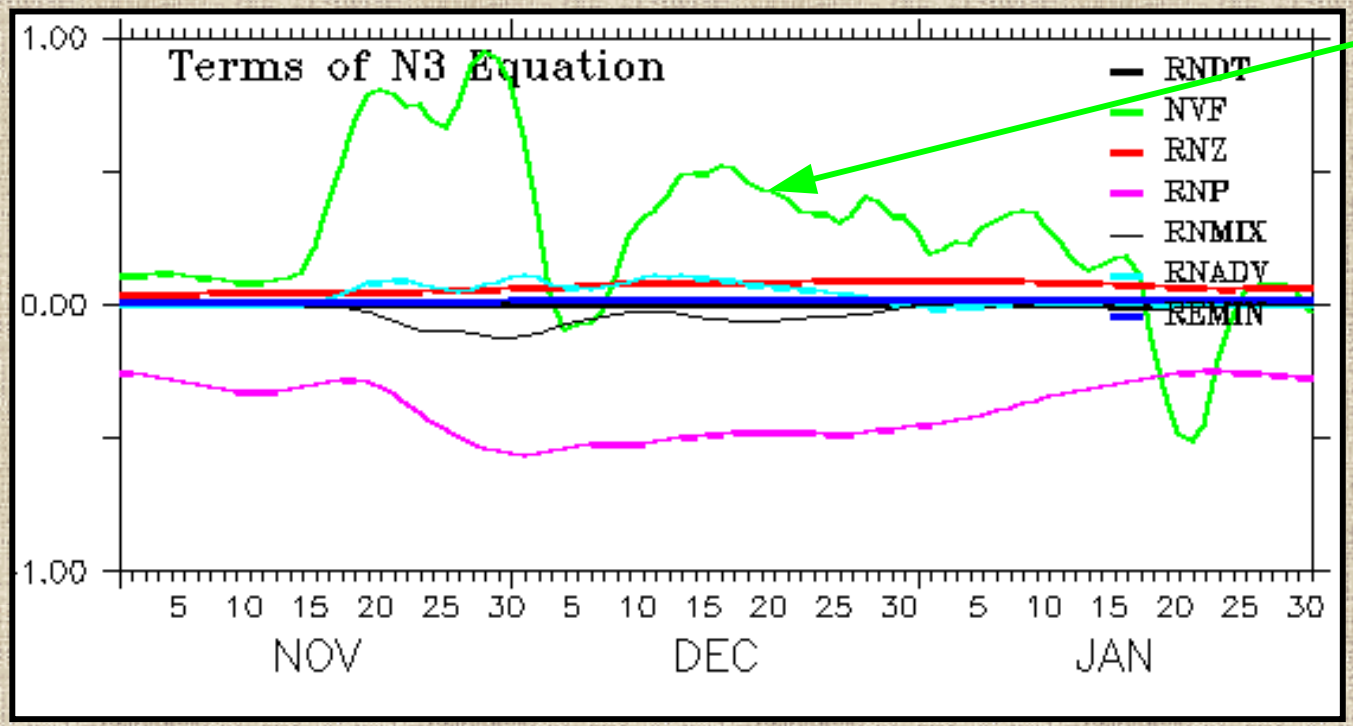
Growth

Nutrient response

Light response

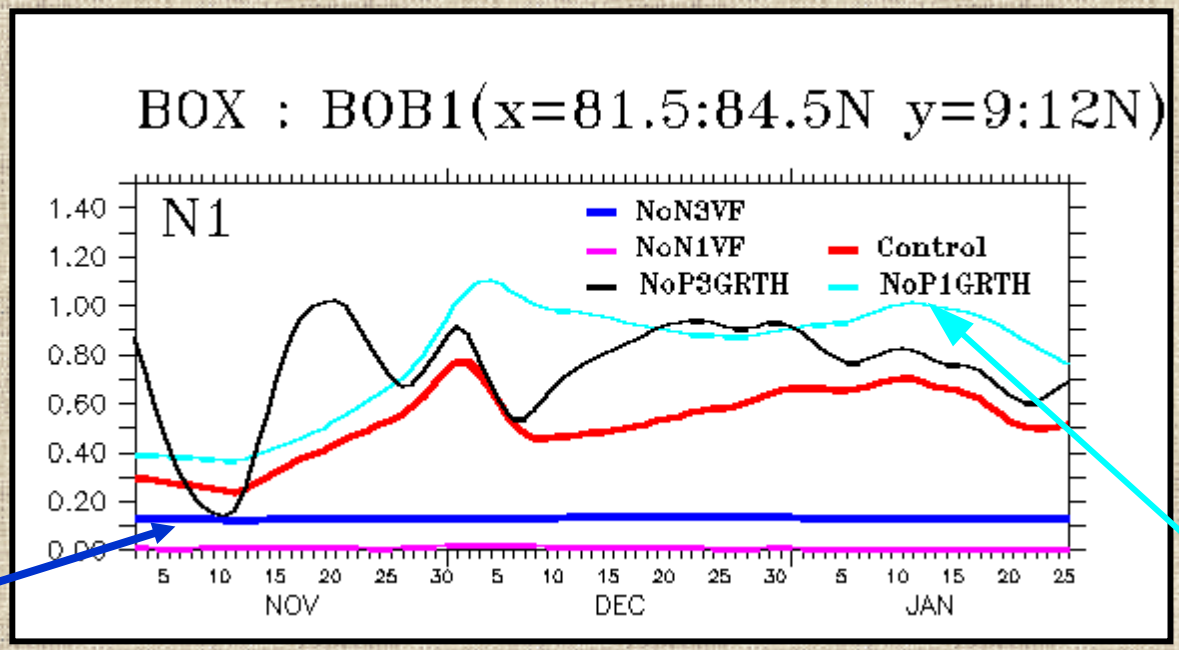
PROCESSES



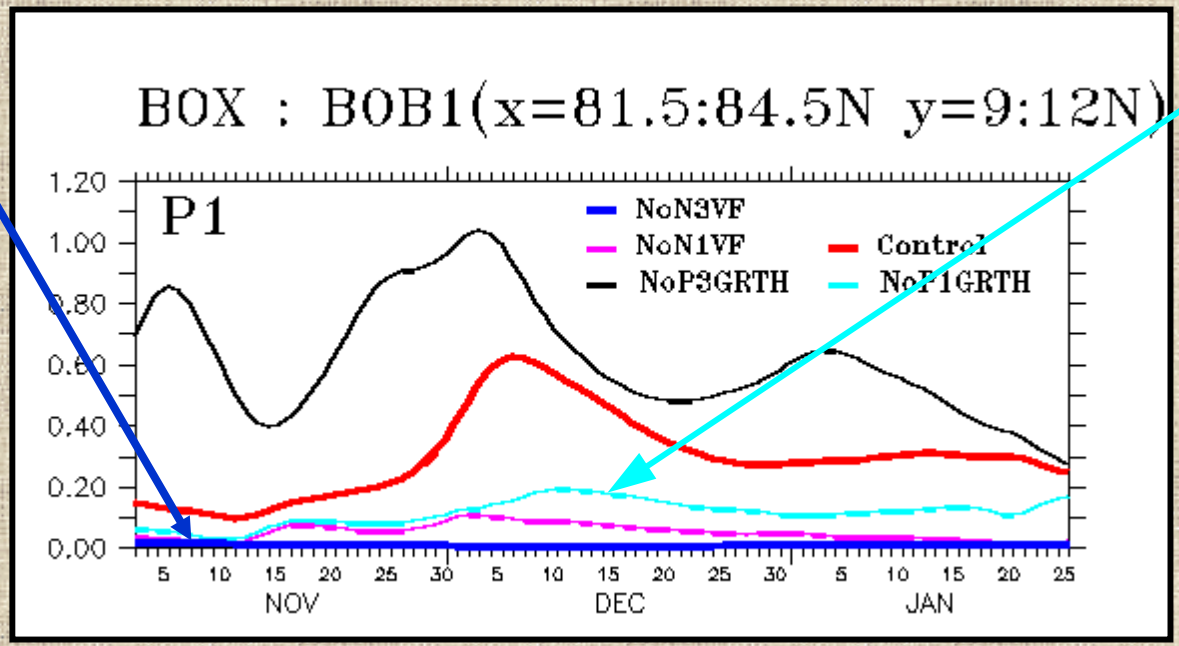


Vertical fluxes

Process Experiments

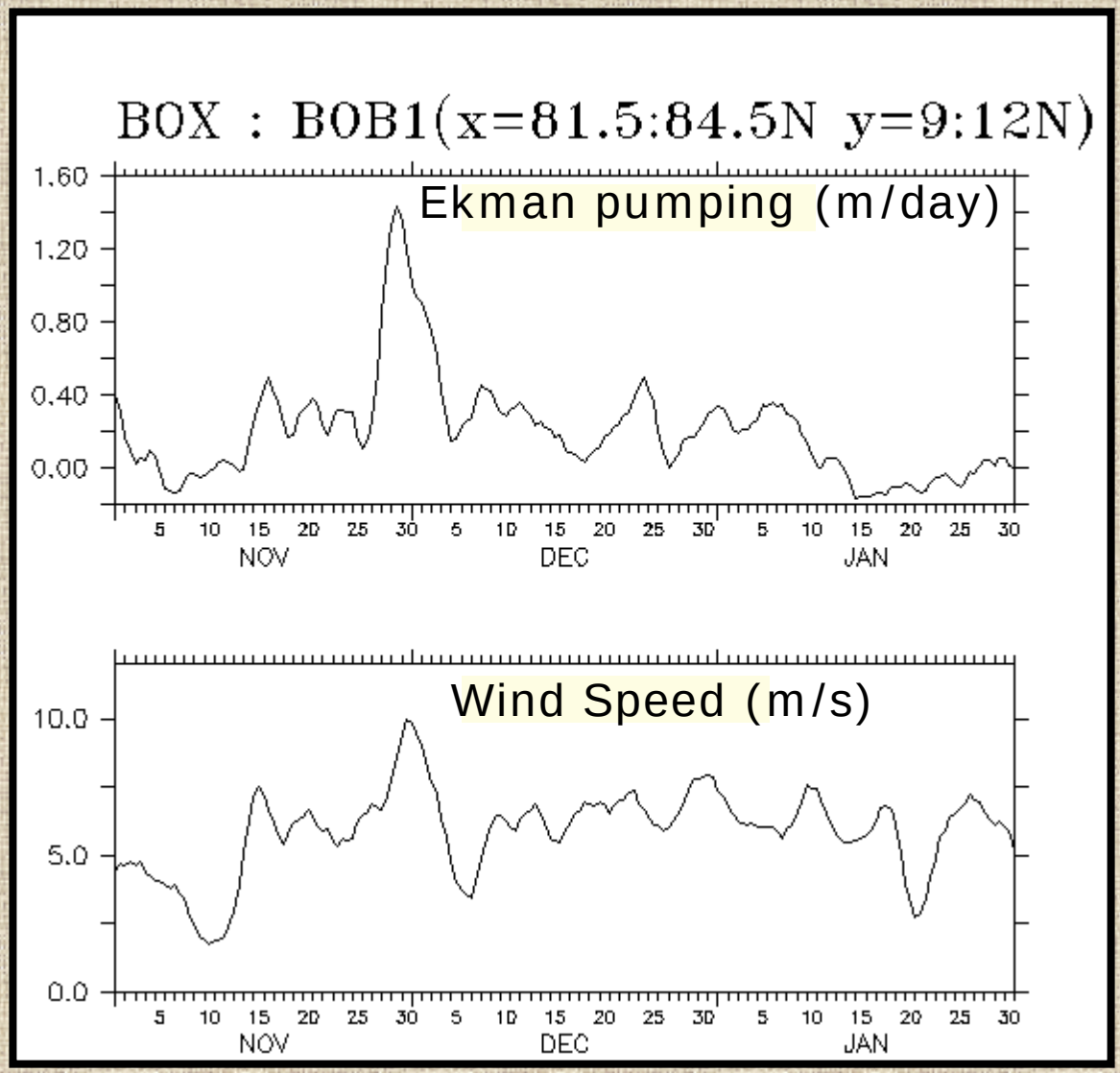


No vertical flux in N3



No P1 growth

Wind Forcing



Conclusions

- ✓Shallowing of the thermocline followed by entrainment causes phytoplankton blooms in the Bay of Bengal.
- ✓Intense wind events, such as cyclones, amplify these physical processes.
- ✓The concentration of P1 in the model is determined by vertical fluxes as well as the growth within the mixed layer.
- ✓The contribution by upward physical transport to the surface bloom is significant in the Bay of Bengal due to the shallow mixed layer.

Thank you