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A numerical study of phytoplankton distribution in Mediterranean Sea

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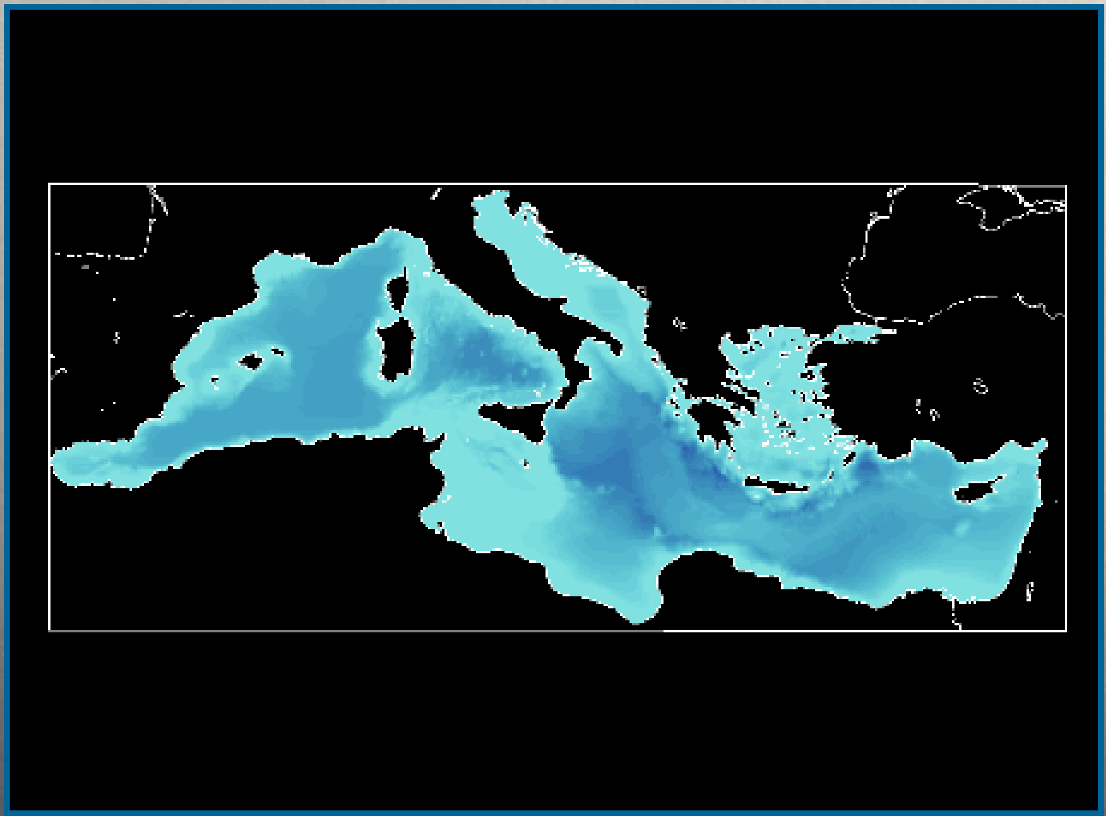
AIM of WORK

- Model phytoplankton seasonal cycle

- Understand the mechanysm that transfert the variability of the forcing function in the ecosystem

- Explain the role of nutrient limitation

Mediterranean physiography



- Midlatitude zonally elongated semienclosed basin
- Limited shelf areas
- Estuarine inverse circulation
- Dominant seasonal cycle

Coupling hydrodynamical and biological modules

- Numerical Integration of hydrodynamical and biological modules at the same time

1980-1988
"Perpetual year"
Wind stress

Irradiance

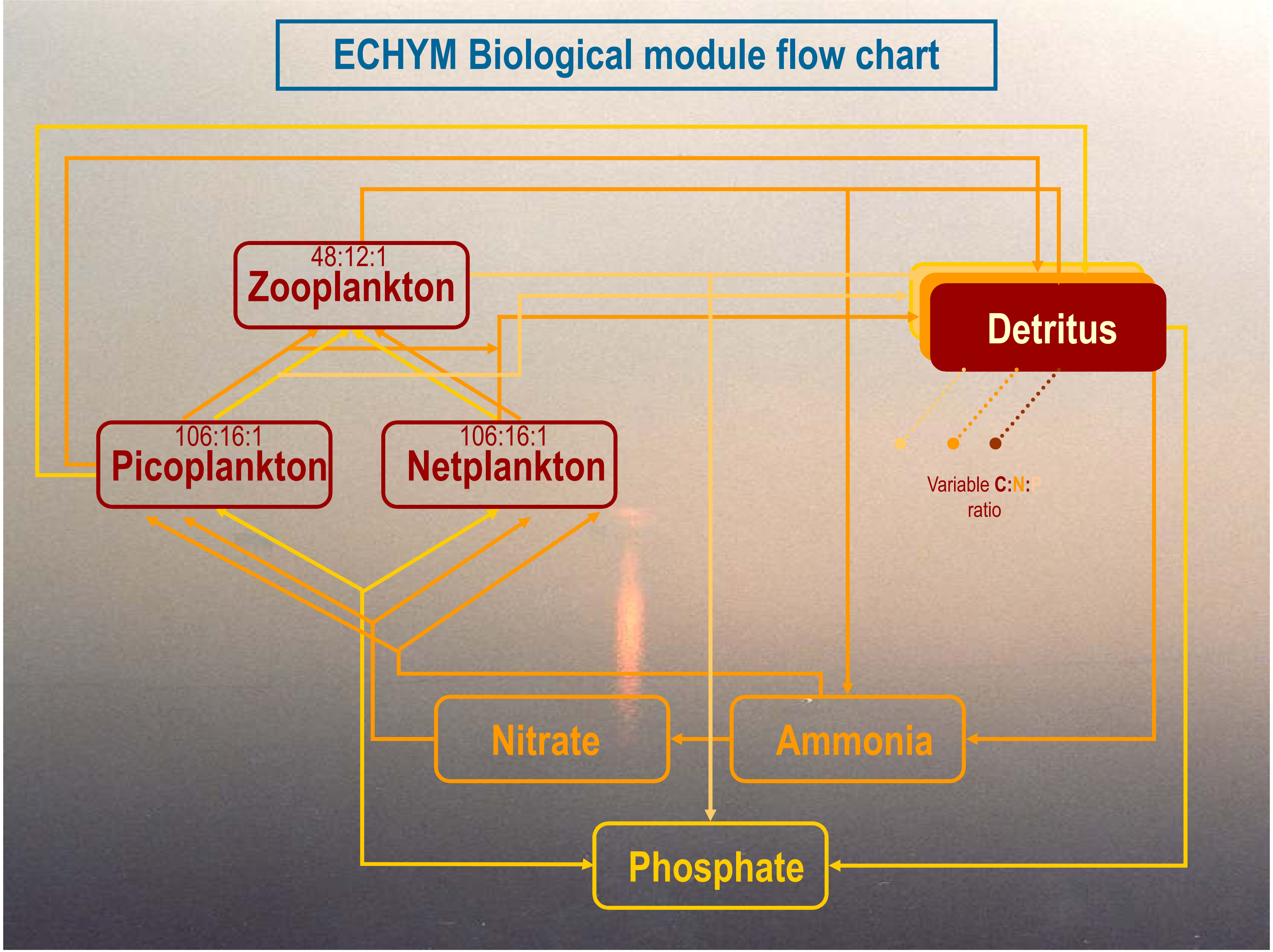
Dynamical module
MOM
¼ degree 31 levels

→

Biological module
ECHYM
¼ degree 31 levels

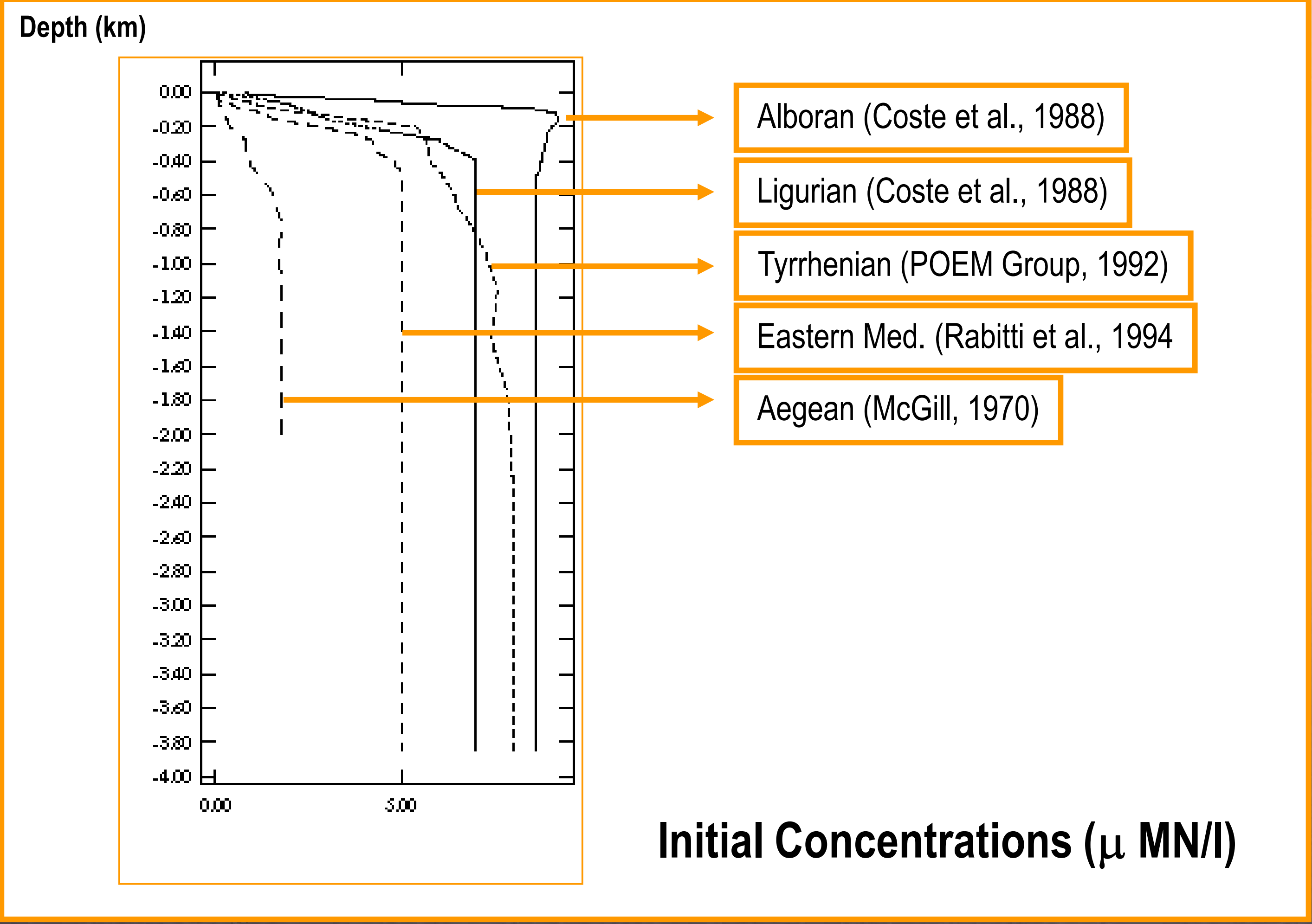
$$\frac{\partial B}{\partial t} = S_{in}(T, PAR, k_v) - S_{out}(T) - U \bullet \nabla B - k_H \nabla^4 B + k_v \frac{\partial^2 B}{\partial Z^2} - W_s \frac{\partial B}{\partial Z}$$

(Crise et al., 1998; Crispi et al., 2002)


ECHYM Biological module flow chart
48:12:1
Zooplankton
106:16:1
Picoplankton
106:16:1
Netplankton
Detritus
Variable C:N:P
ratio
Nitrate
Ammonia
Phosphate

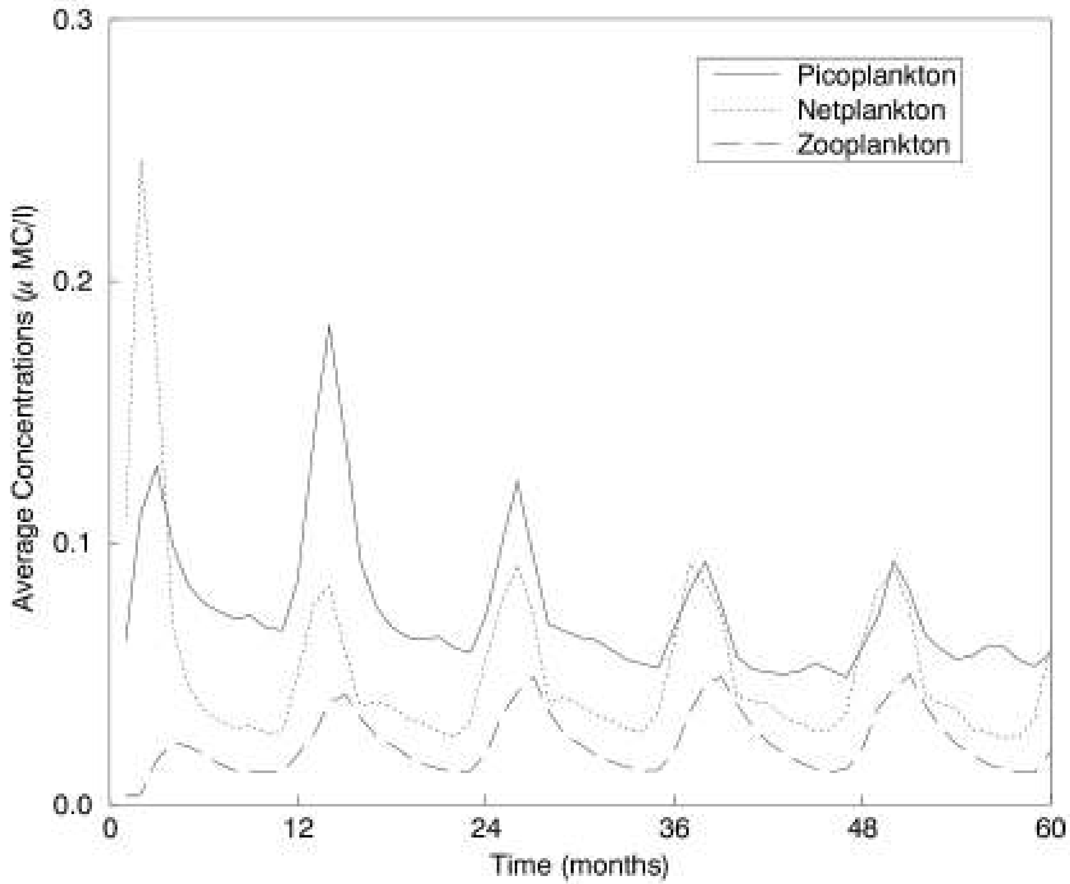
Initial conditions for Nutrients

- Subbasinwide constant profiles
- Redfield ration for PO_4

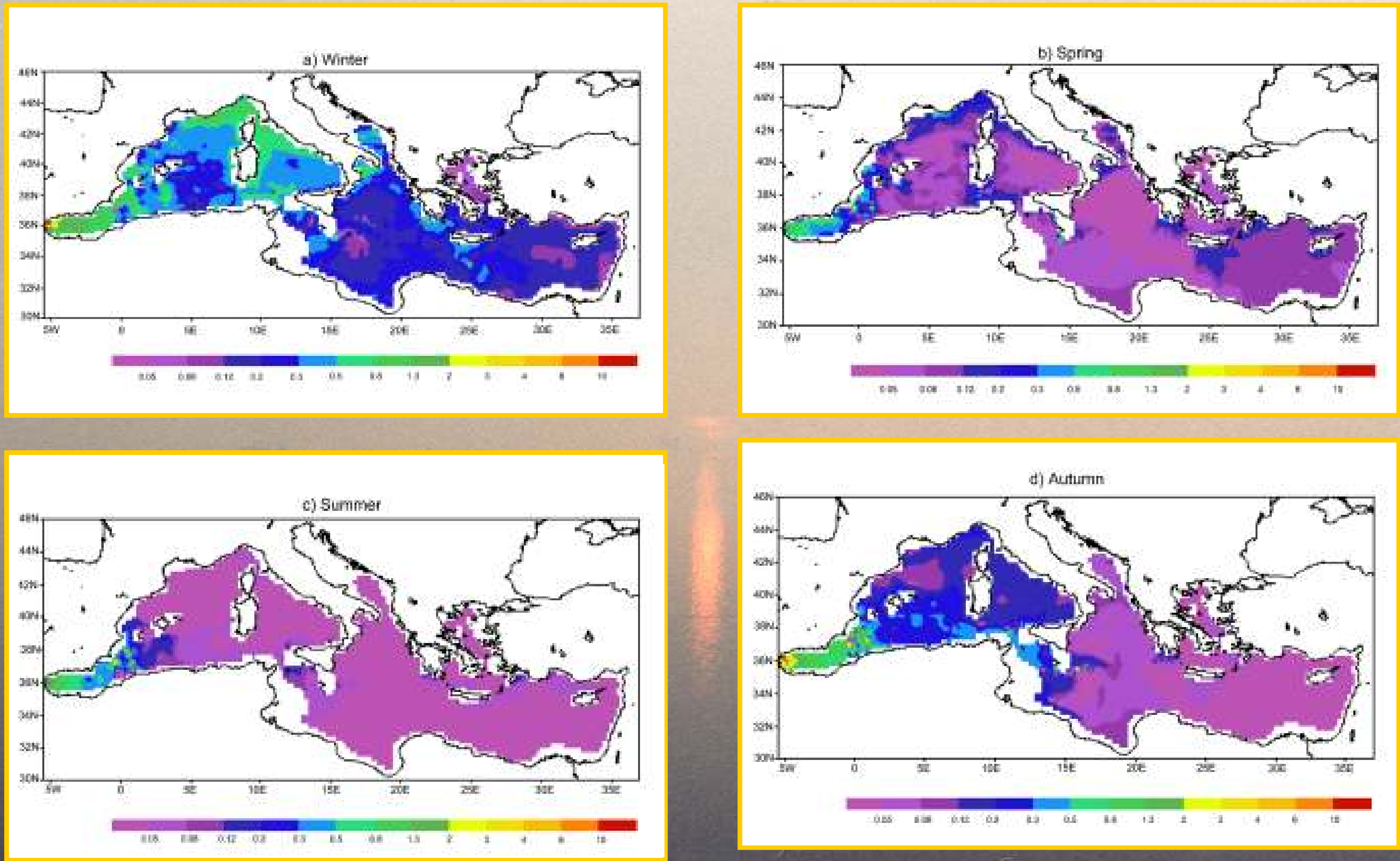


Model Spinup

- Five year for thew dynamical module + five years for the coupled model

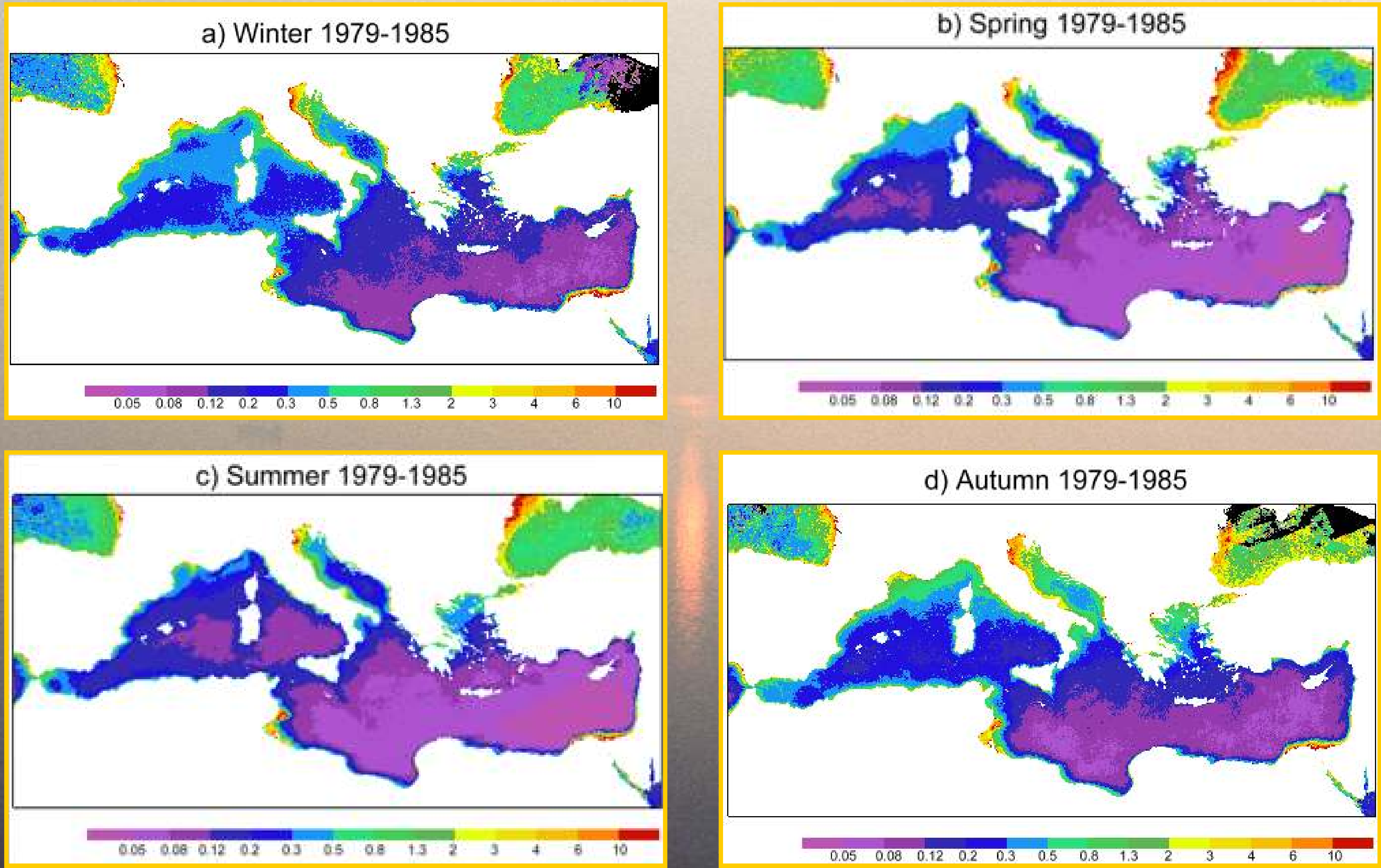


Chlorophyll concentration in the first optical length (mgChl/m^3)
Model estimates in pelagic waters (depth> 200m)

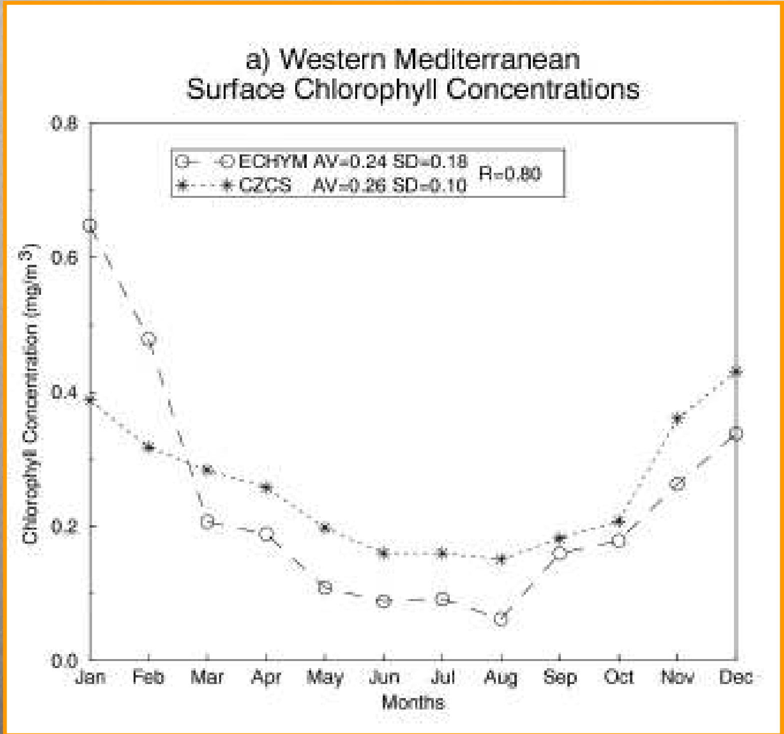


Variable C:Chl ratio calculated according with Cloern et al. (1995) empirical model

Chlorophyll concentration in the first optical length (mgChl/m^3)
CZCS seasonal averages (JRC-Ispra, modified)

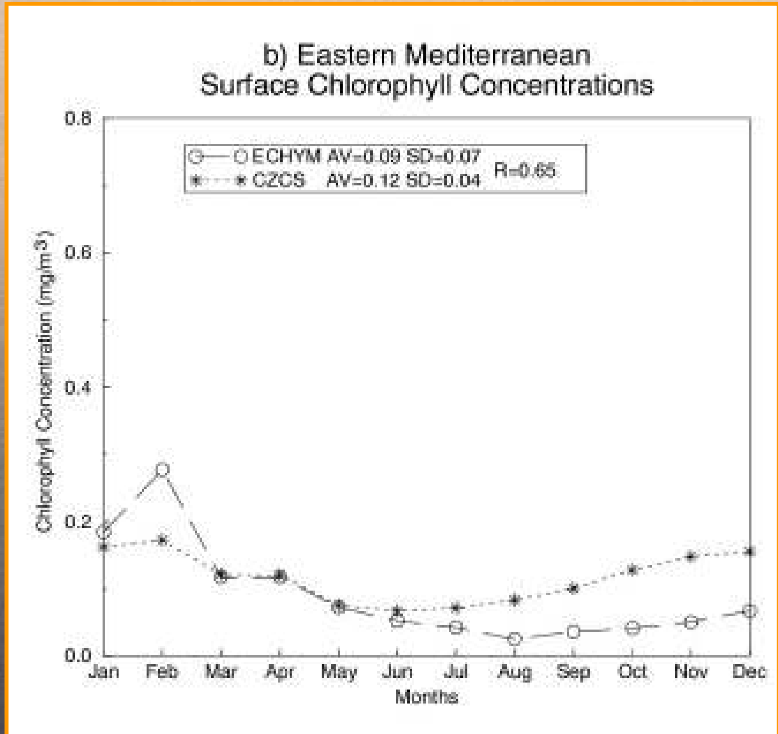


Comparison ECHYM - CZCS

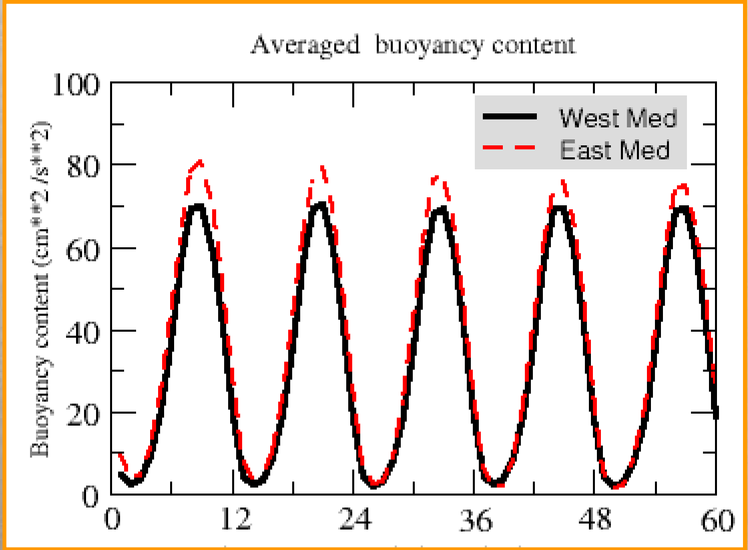


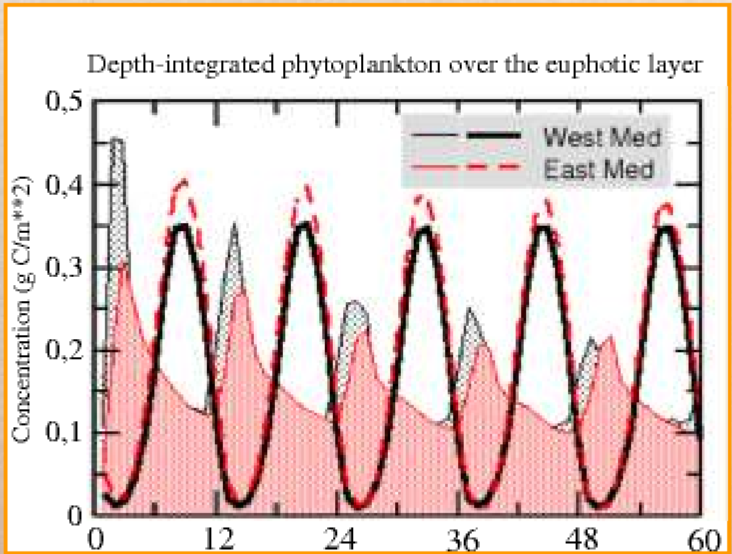
Primary production

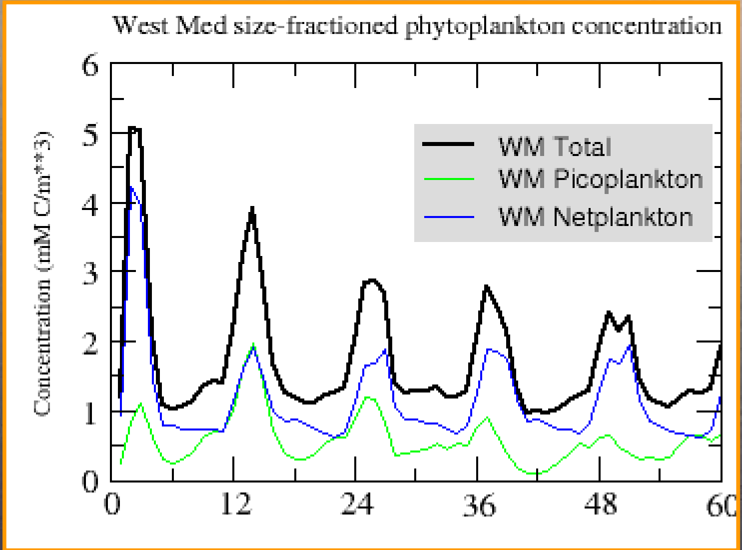
	West Med	East Med
ECHYM (Crispi et al., 2002)	**32** (small) **88** (large) **120** (total)	**38** (small) **18** (large) **56** (total)
Observations (Turley et al., 2000)	**183** (NW Med)	**55** (Cretan Sea)
CZCS (Antoine et al., 1995)	**157.7**	**109.4** (including Adriatic and Aegean Seas)

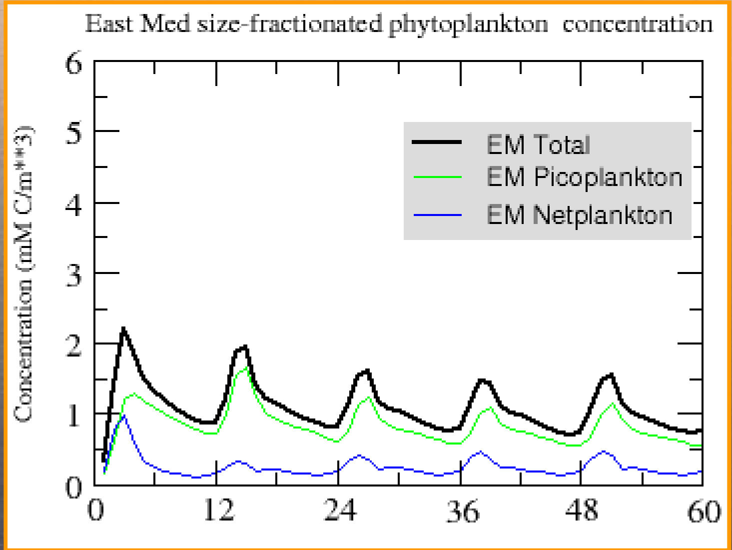


Buoyancy content above the nutricline and phytoplankton seasonal cycle

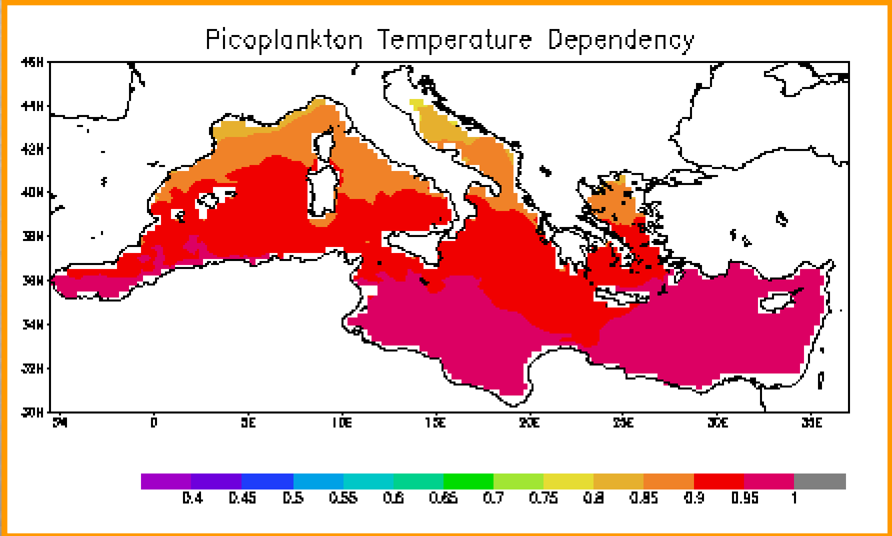


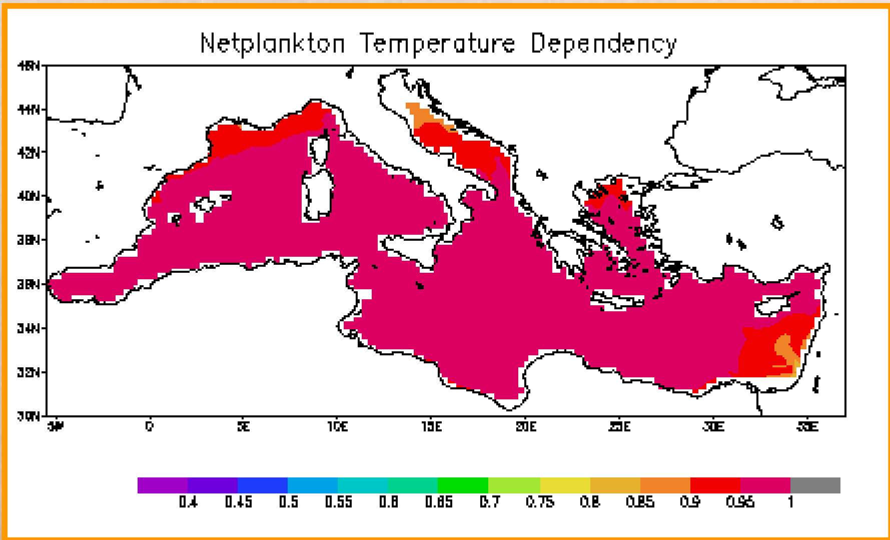


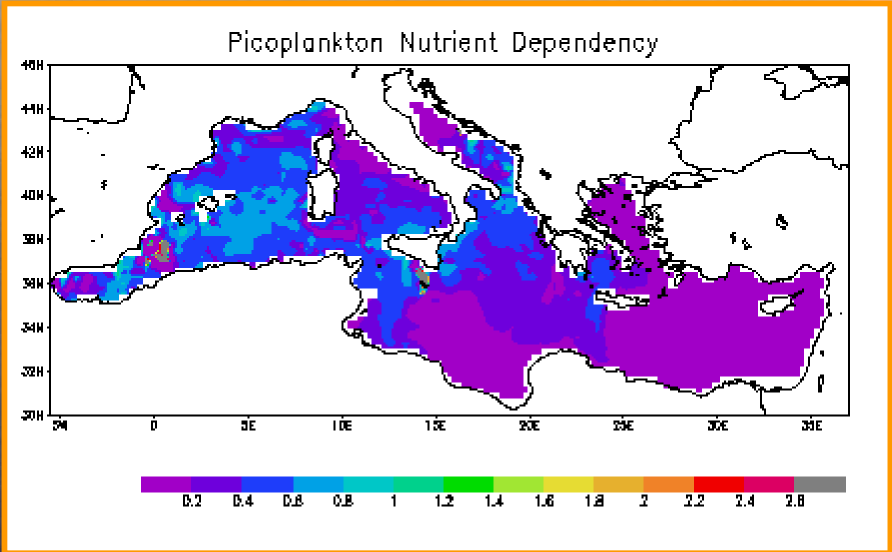


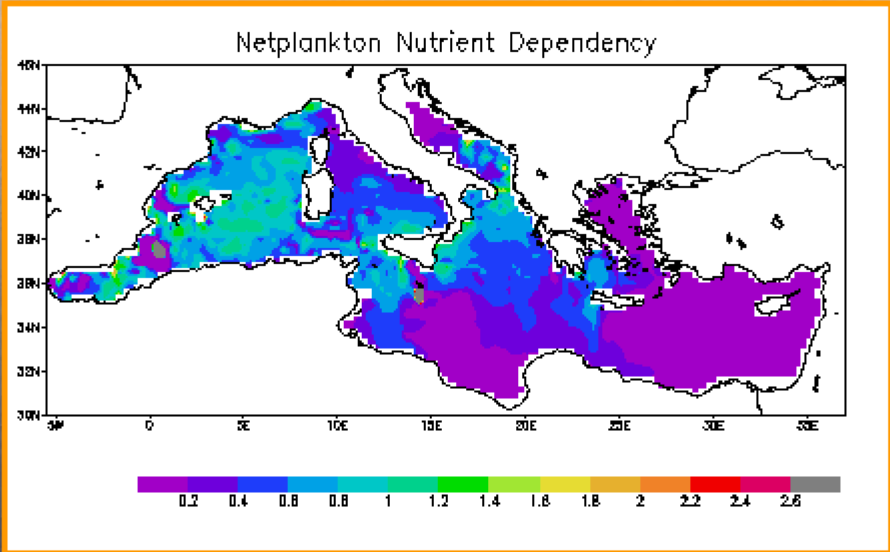


Phytoplankton limitation: temperature and nutrient (April)

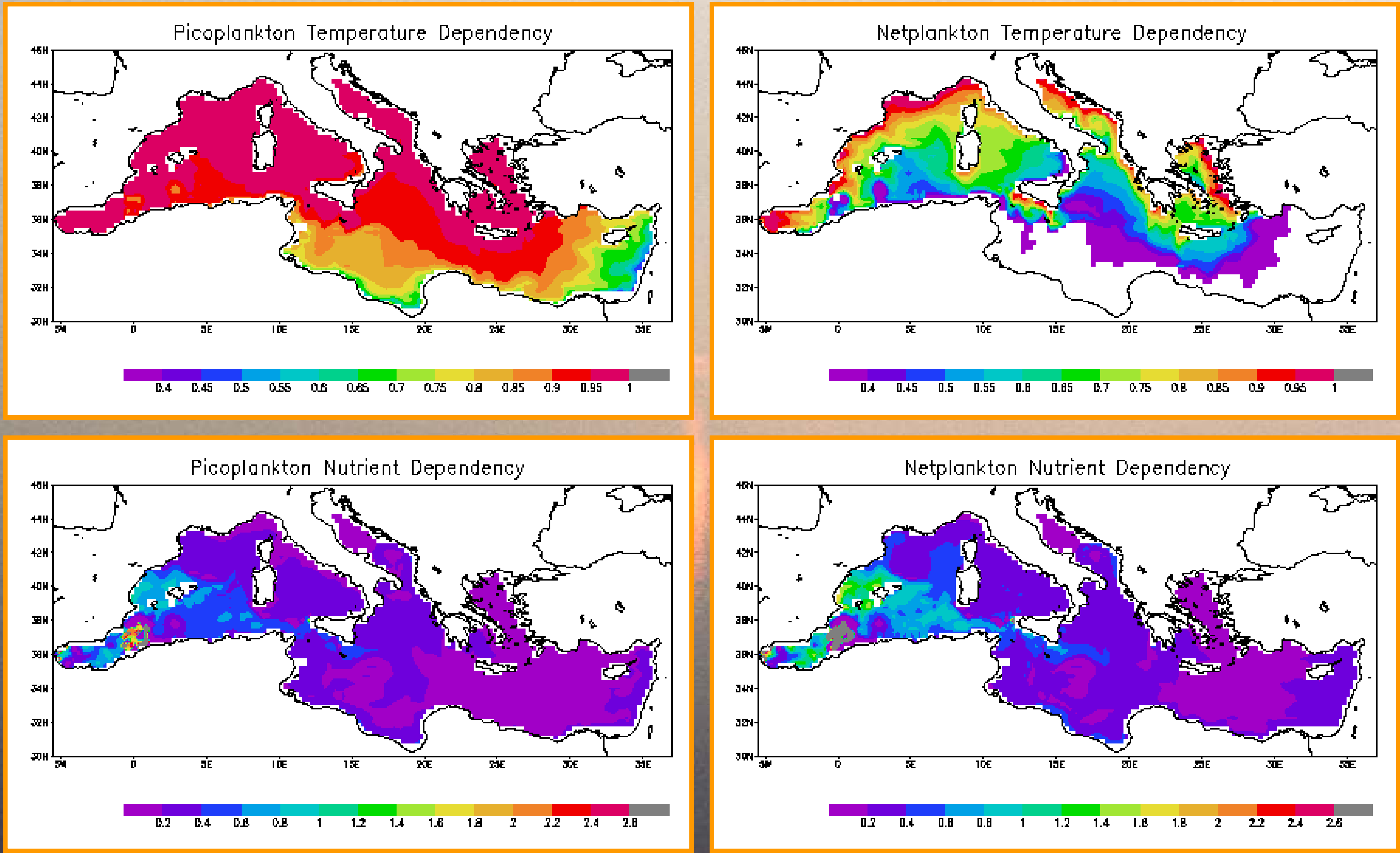






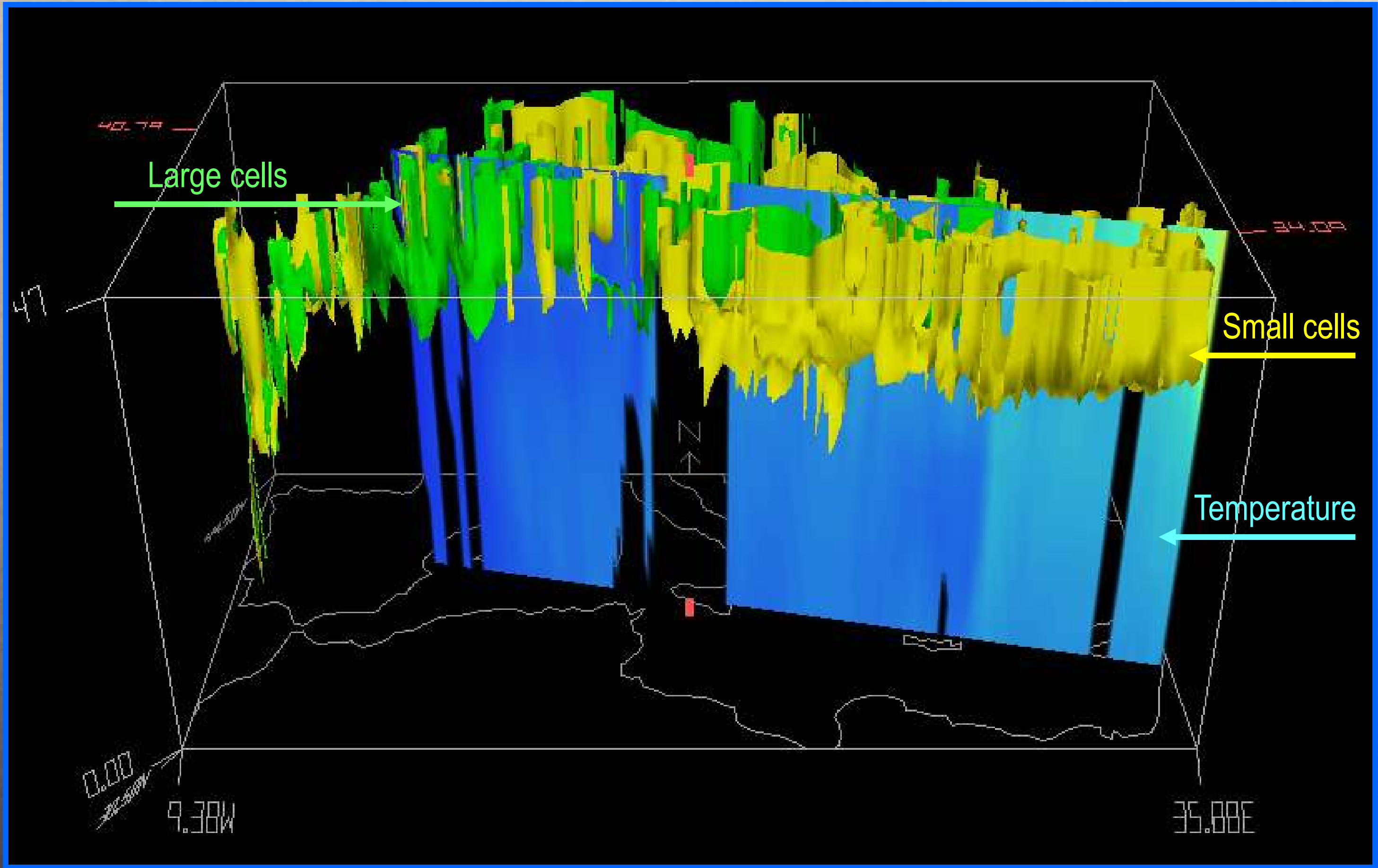


Phytoplankton limitation: temperature and nutrient (October)



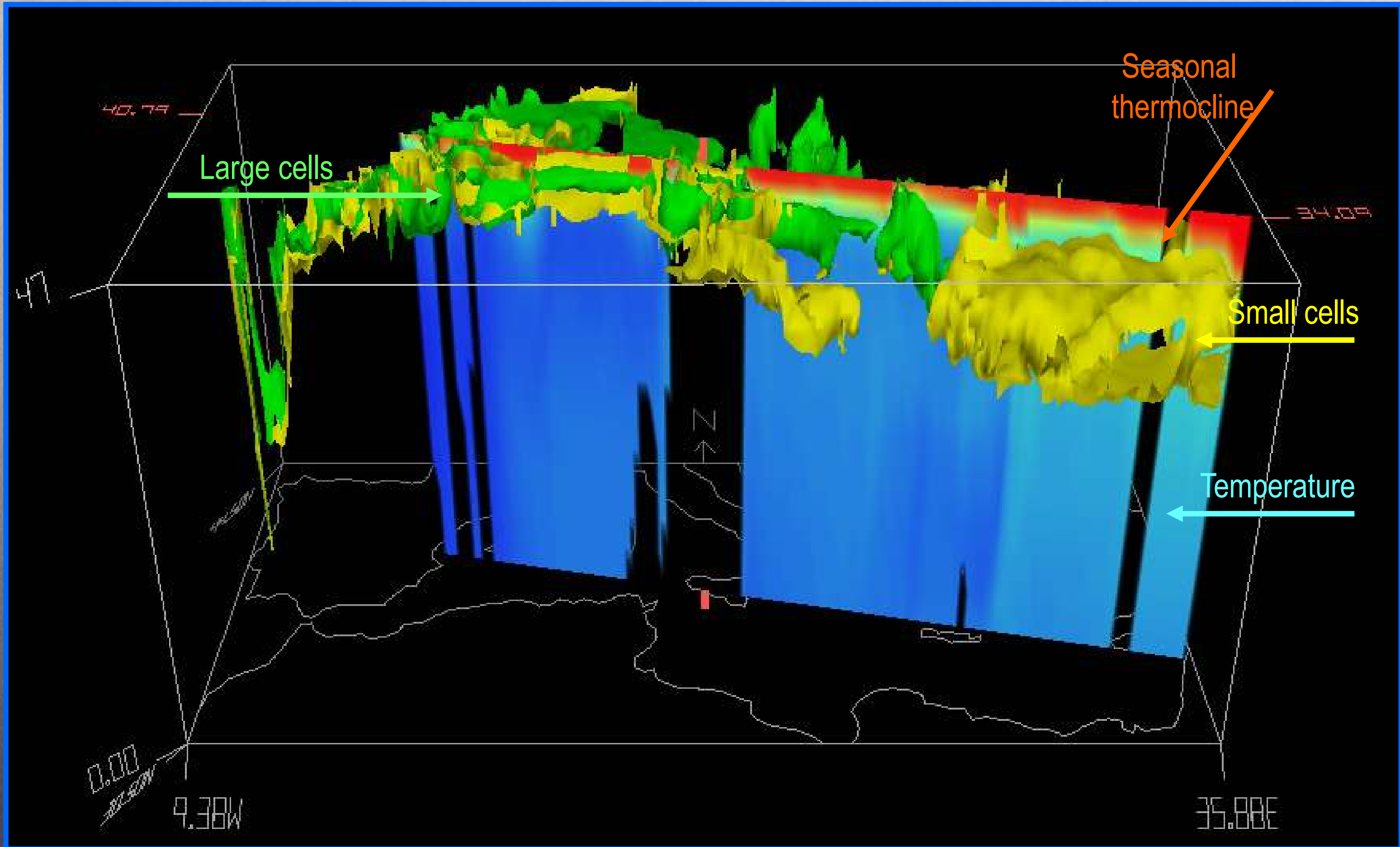
Phytoplankton concentration in January

- Prevailing vertical processes
- East West gradient
- Large cells dominant in the western basin



Phytoplankton concentration in October

- Prevailing vertical processes
- East West gradient
- Large cells dominant in the western basin



CONCLUSIONS

- ECHYM model simulations of phytoplankton seasonal cycle successfully compares against data

- Buoyancy content above the nutricline acts as transfer function between the forcing seasonal cycle and the ecosystem response

- Phytoplanktonic blooms seem to be controlled always by nutrient availability

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