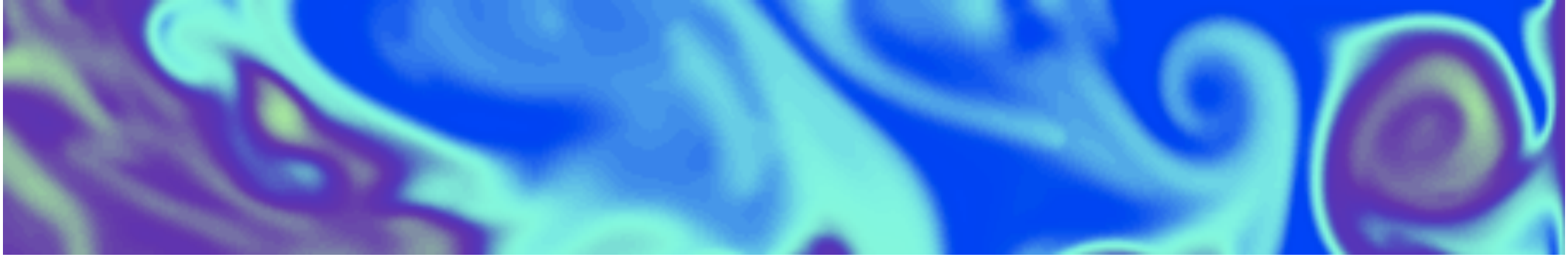


Interannual variability of phytoplankton bloom driven by mesoscale turbulence

Marina Lévy

OSI Symposium, June 2014 LOCEAN-IPSL, France

LOCEAN

Institut Pierre Simon Laplace

Institut de recherche en science

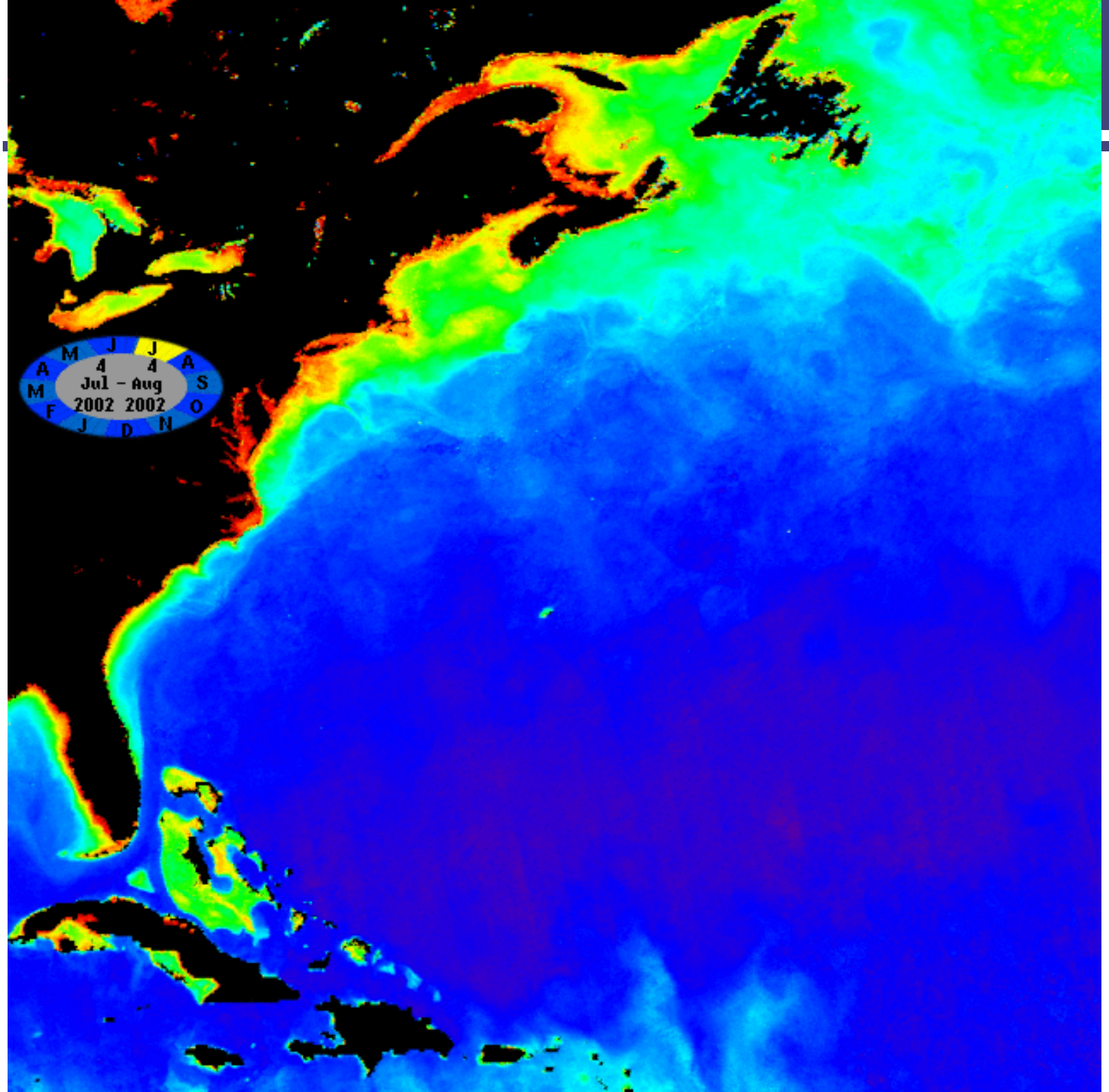
cnrs

dépasser les frontières

Ifremer

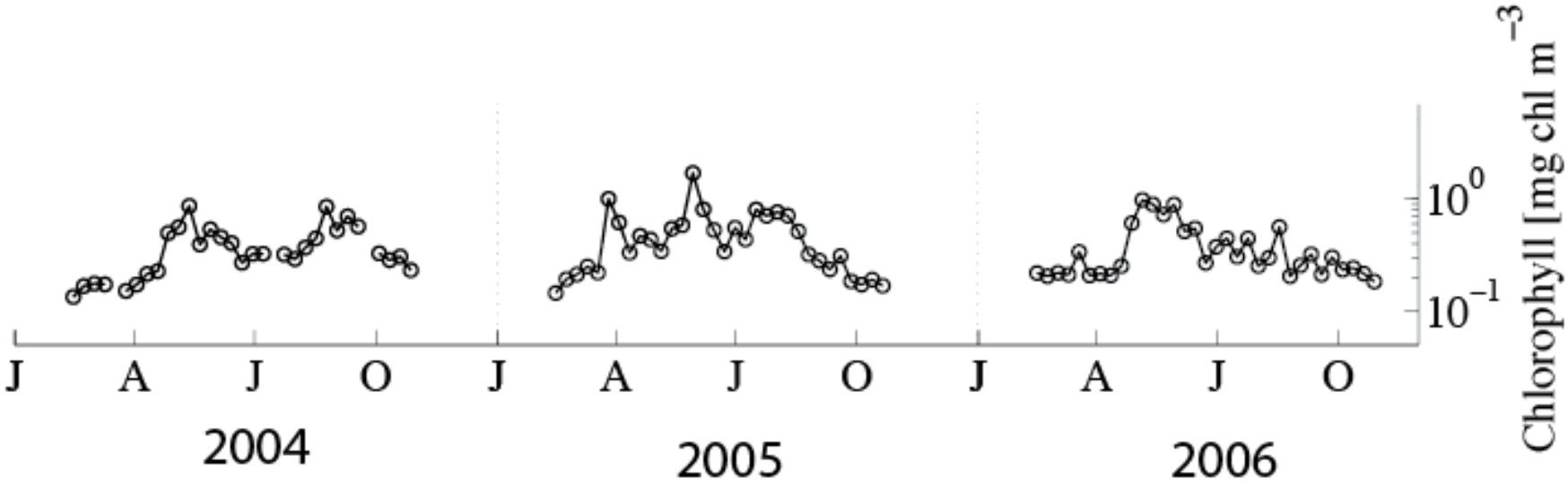
EARTH SIMULATOR

Motivation



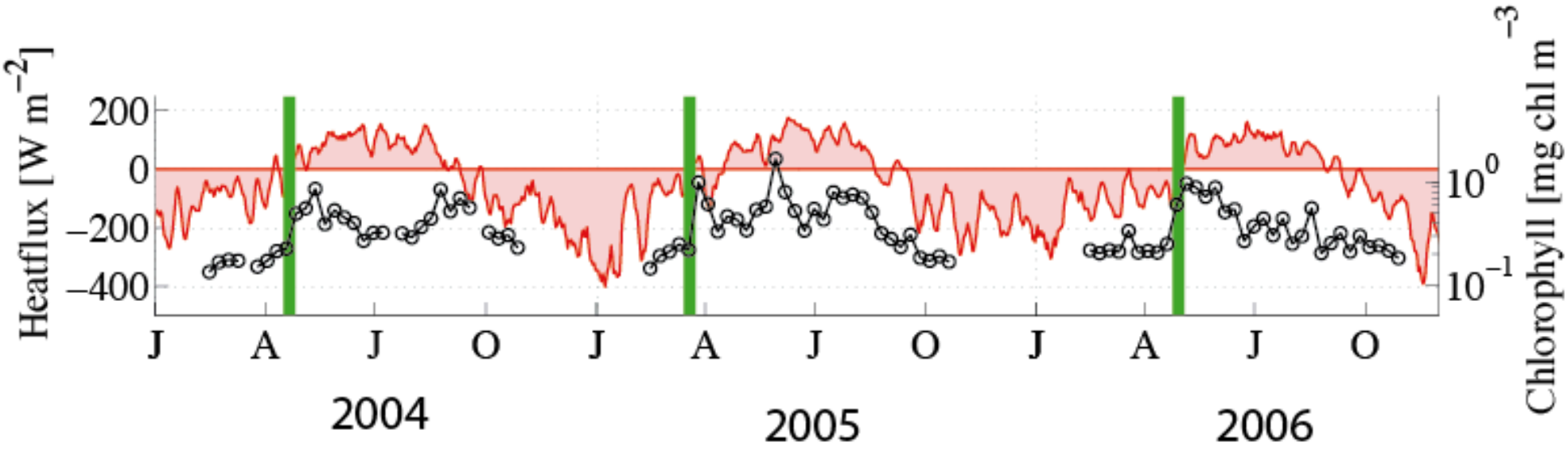
SeaWifs
Ocean color data
2002-2007

Motivation



Interannual variability in bloom timing and intensity

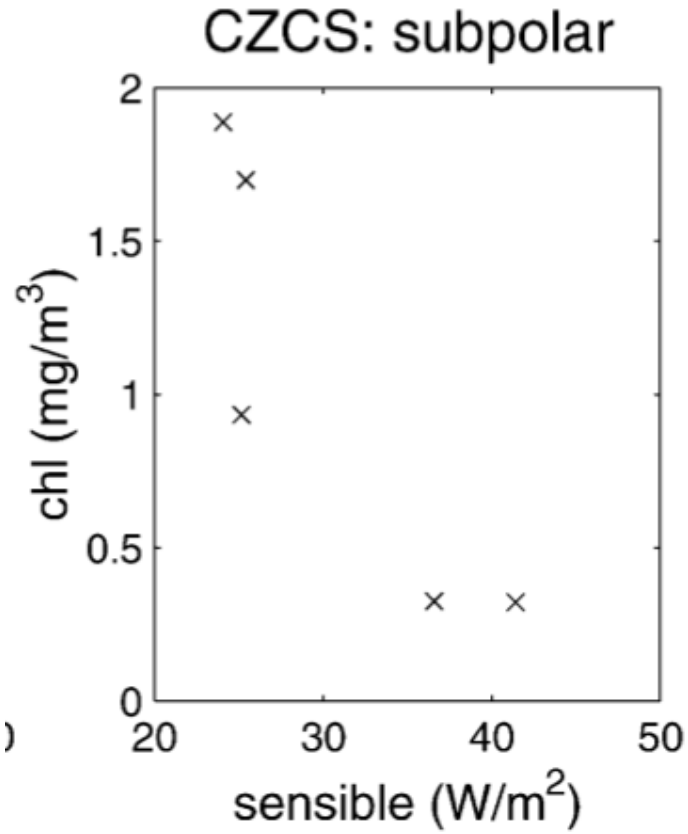
Motivation



Interannual variability in bloom timing related to variability in air-sea Heat flux

Ferrari et al., 2014

Motivation

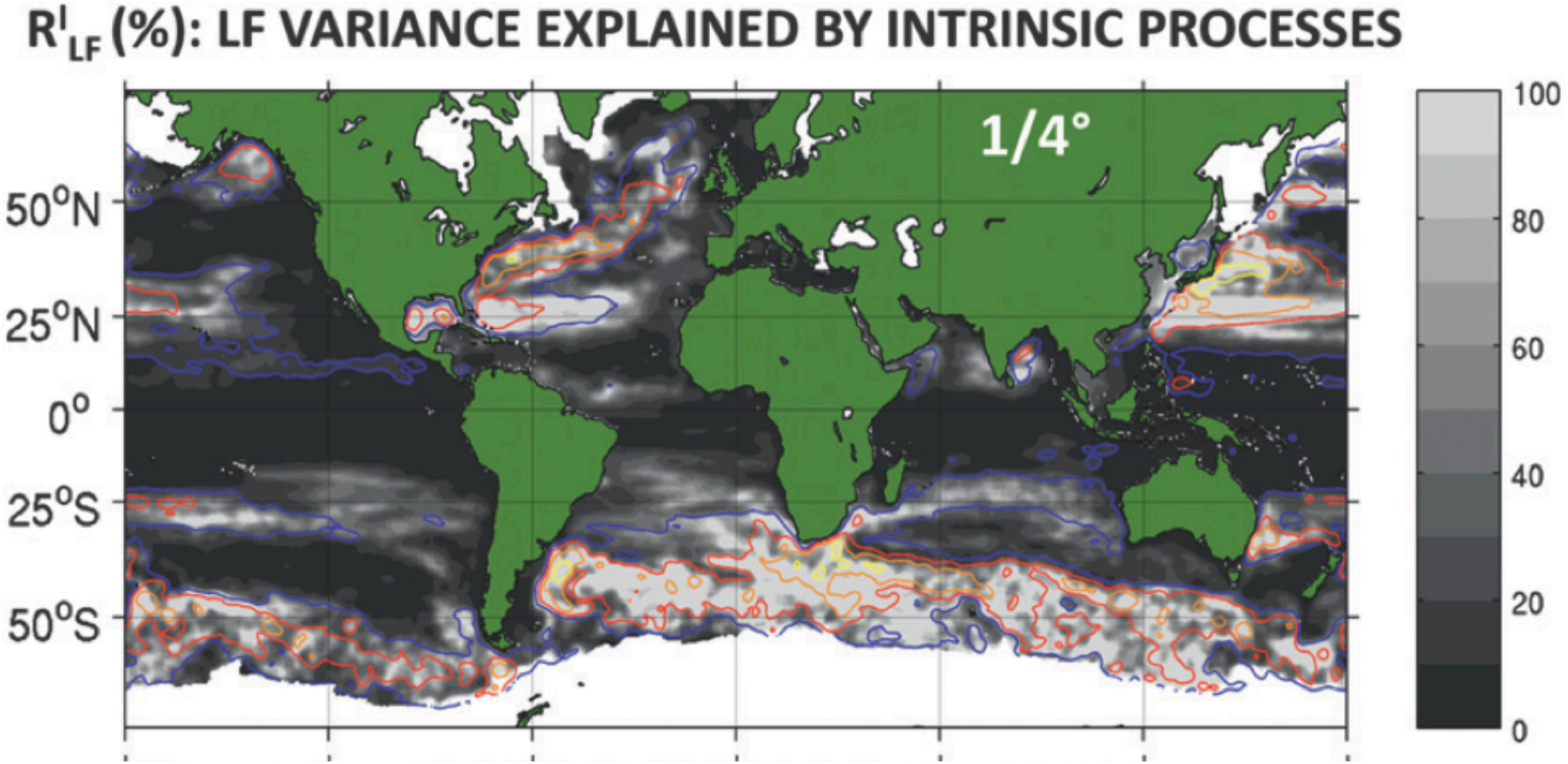


1979-1986 CZCS Ocean color data
NCEP sensible heat flux

Interannual variability in bloom intensity related to variability in sensible heat flux

Dutkiewicz et al., 2001

Interrannual variability in bloom timing and amplitude has been successfully attributed to variability in the atmospheric forcing



Sea Level Expression of Intrinsic and Forced Ocean Variabilities at Interannual Time Scales

Penduff et al., 2011

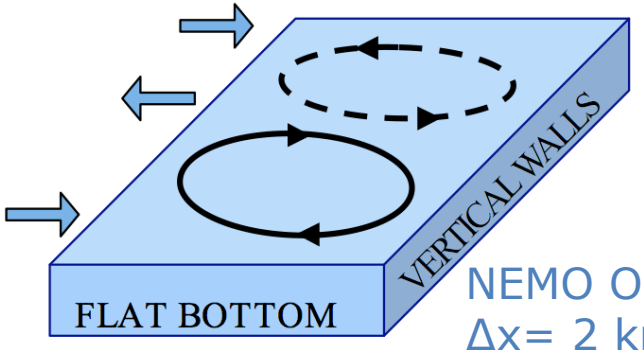
Objectives

Does intrinsic variability generate variability in bloom timing and amplitude ?

Is this variability significant compared to the atmospherically forced variability ?

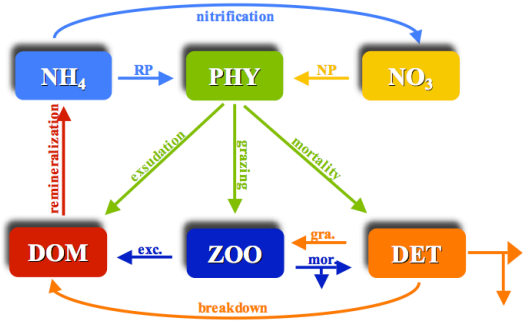
What model resolution is needed to capture it ?

Method

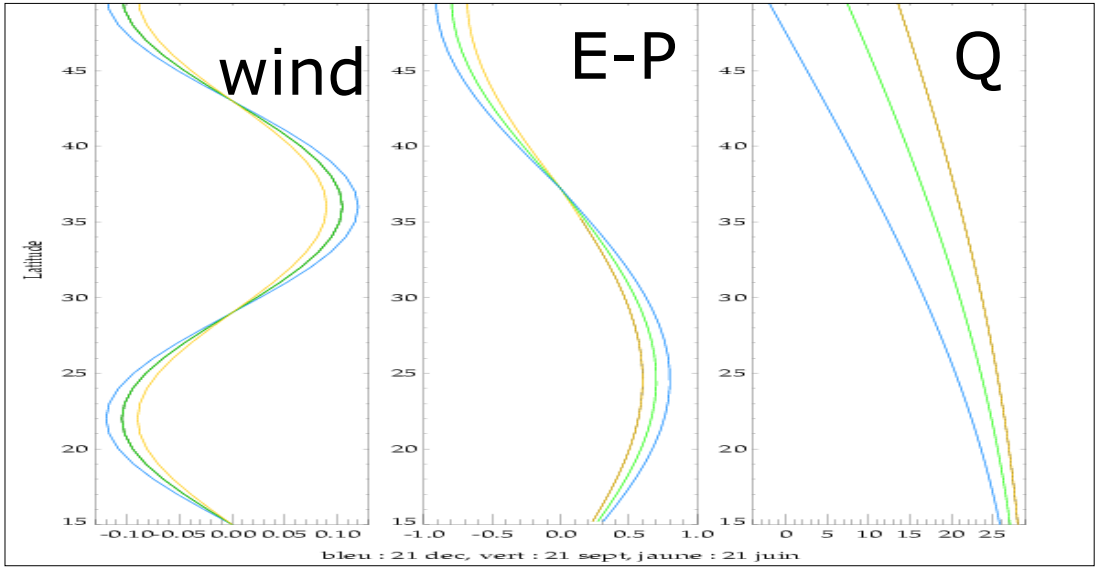


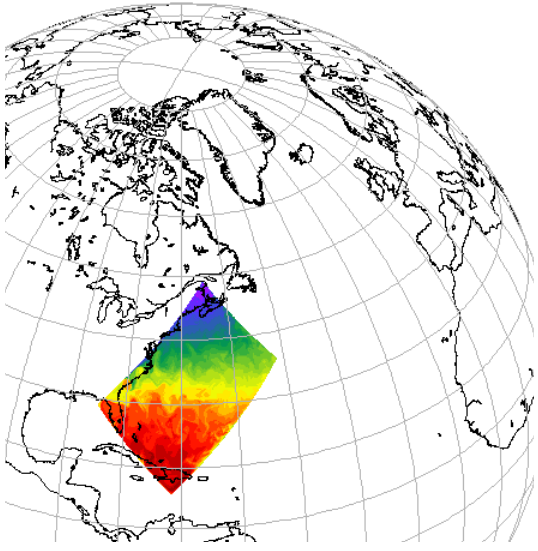
NEMO OGCM
Δx= 2 km

+



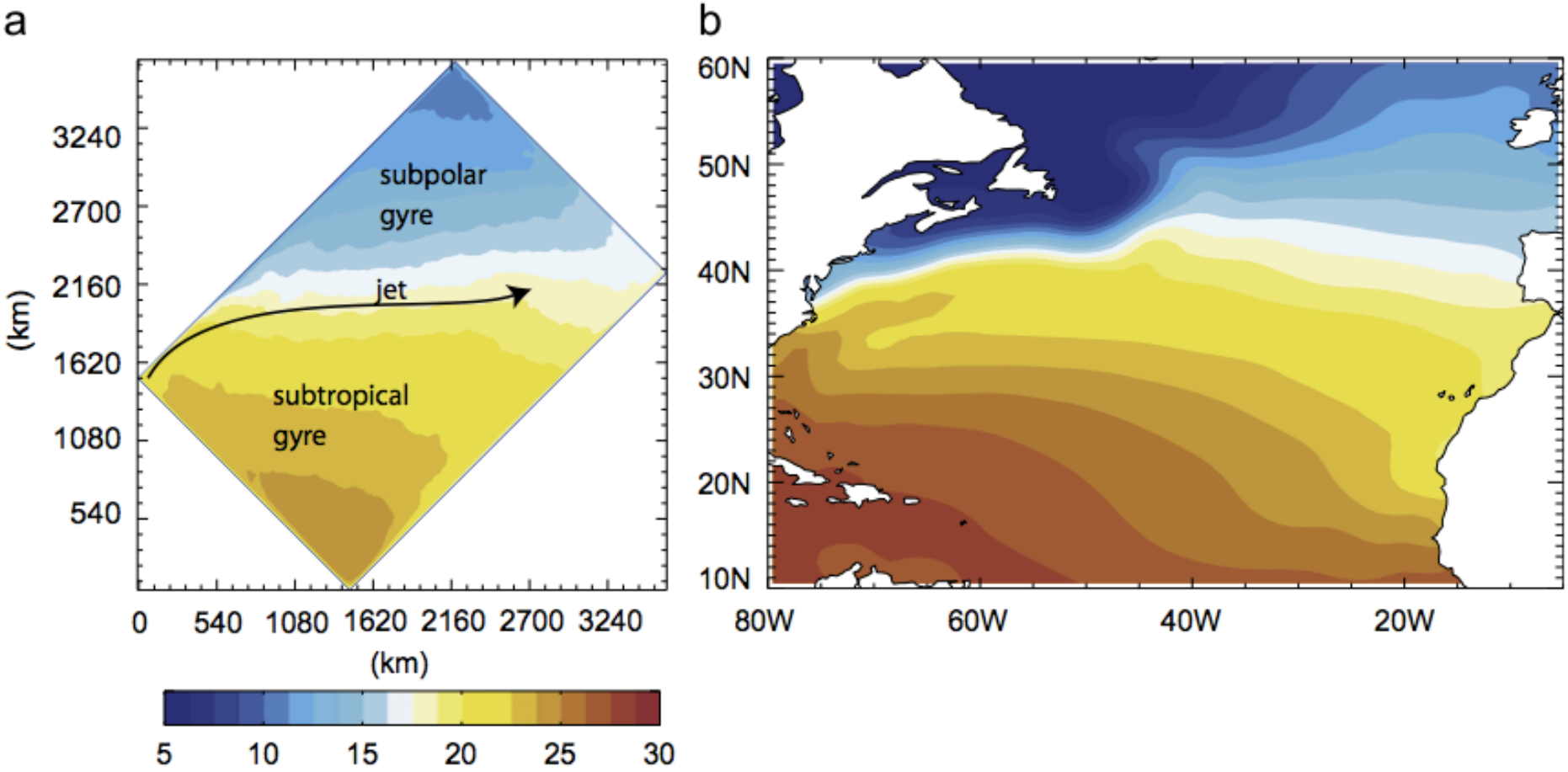
Climatological forcing



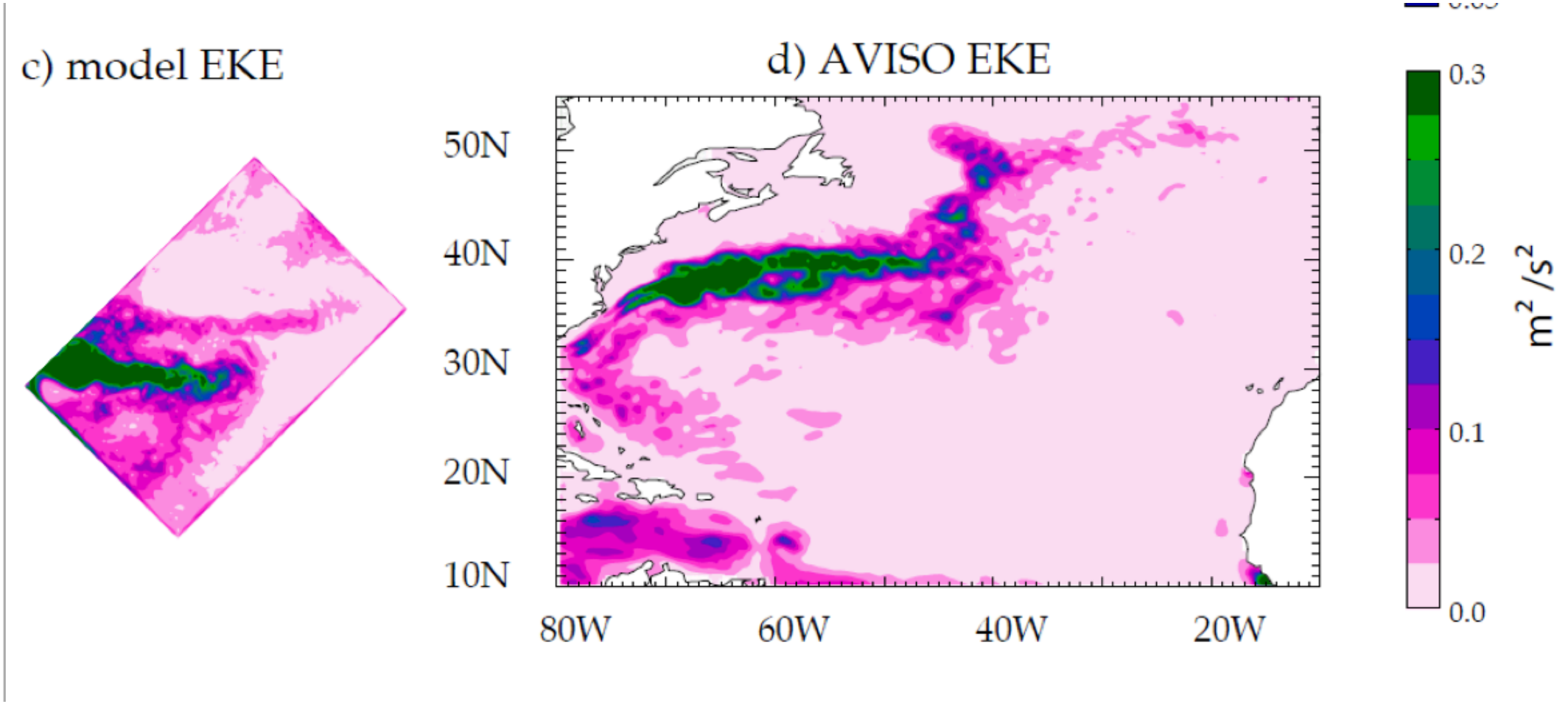


50 years of spin-up, daily outputs for last 5 years

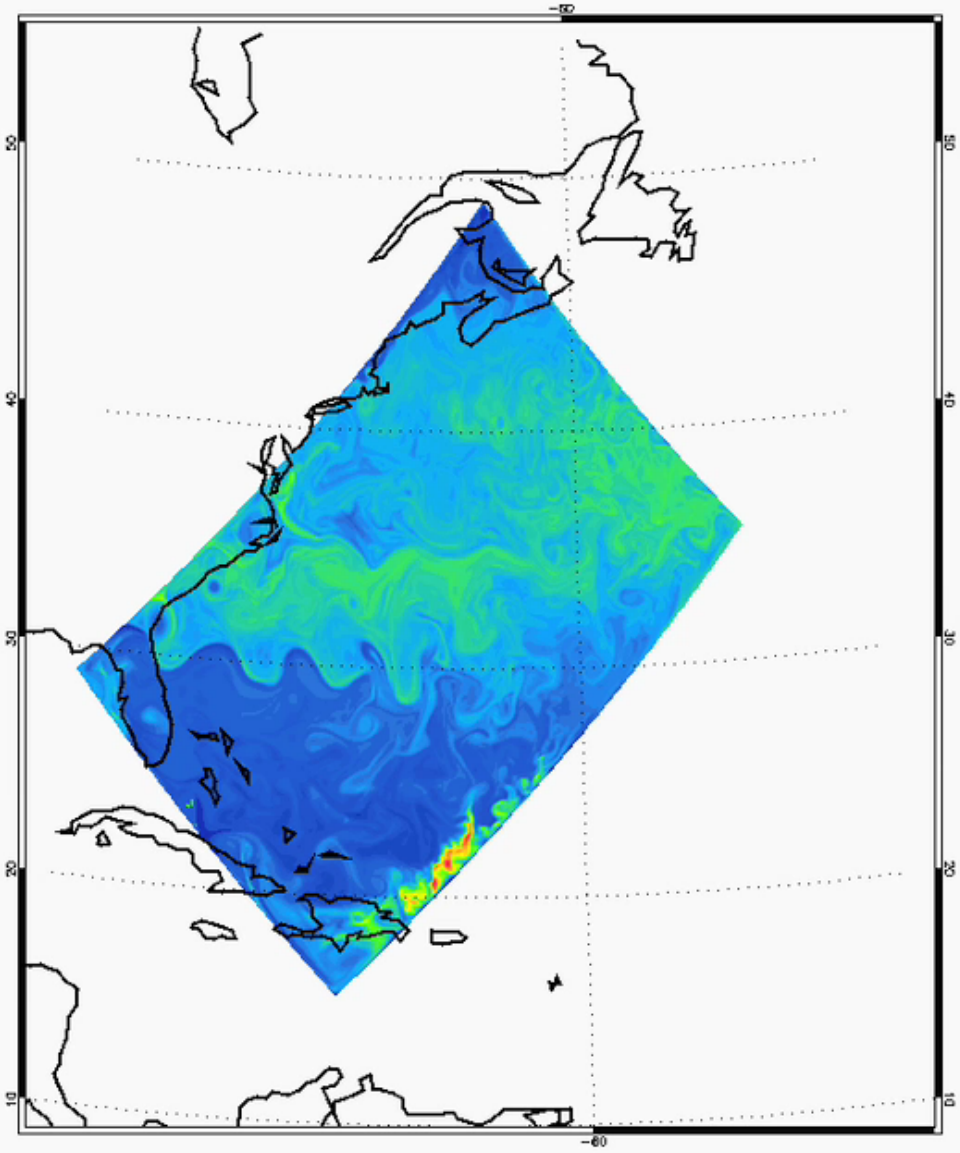
SST


a
b
3240
2700
2160
1620
1080
540
(km)
subpolar
gyre
jet
subtropical
gyre
0
540
1080
1620
2160
2700
3240
(km)
5
10
15
20
25
30
60N
50N
40N
30N
20N
10N
80W
60W
40W
20W

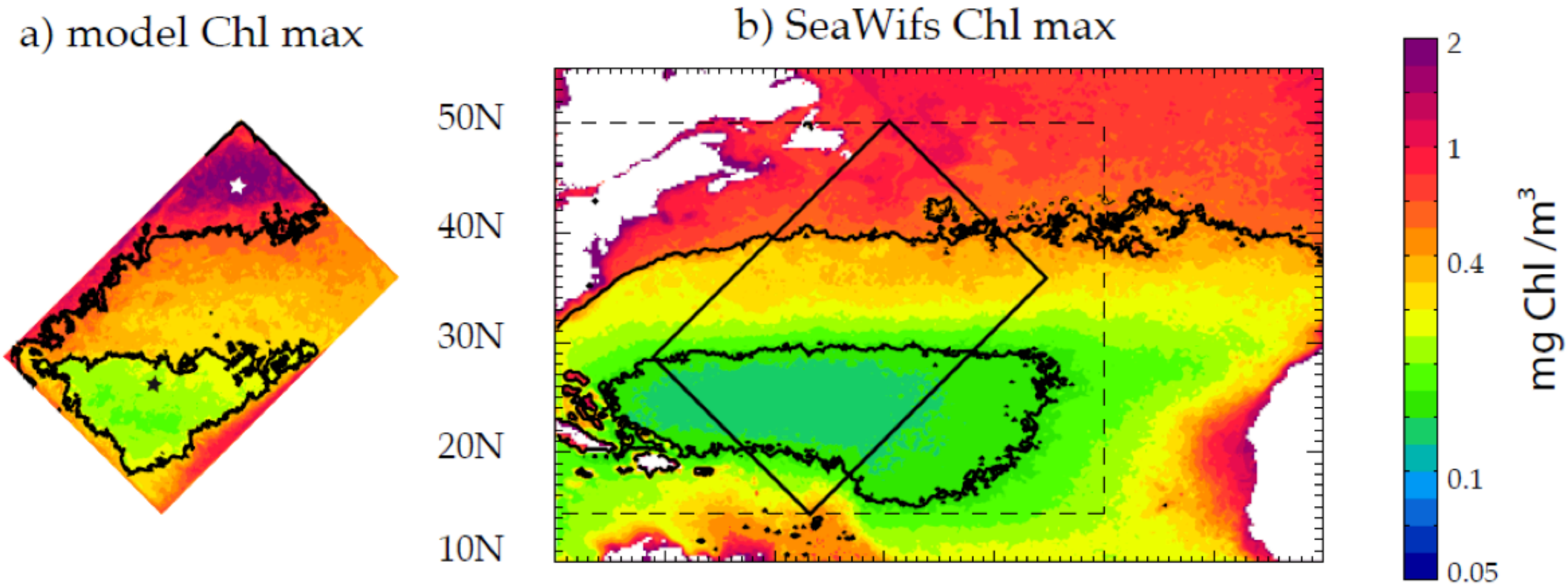
EKE

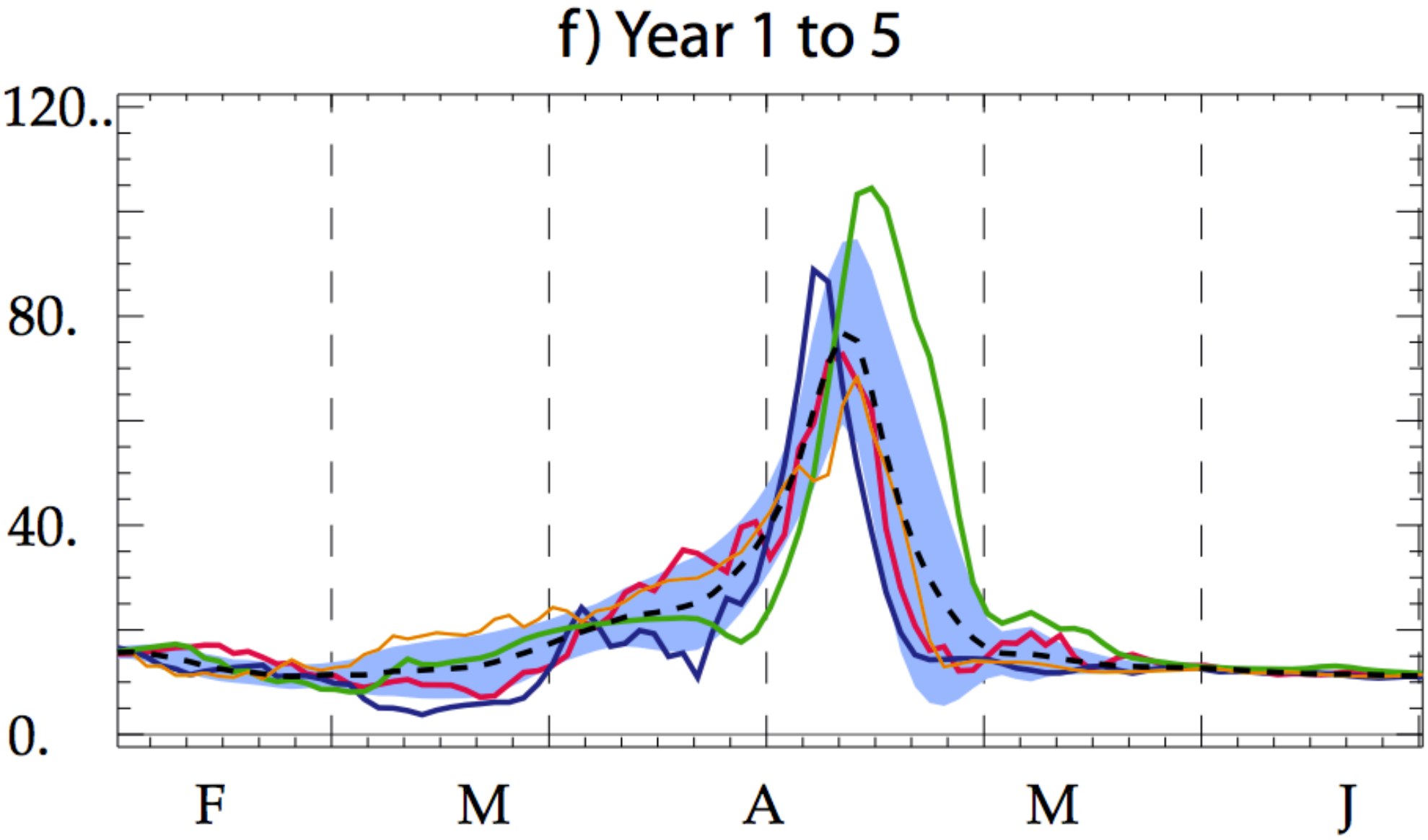

c) model EKE
d) AVISO EKE
50N
40N
30N
20N
10N
80W
60W
40W
20W
0.3
0.2
0.1
0.0
m²/s²

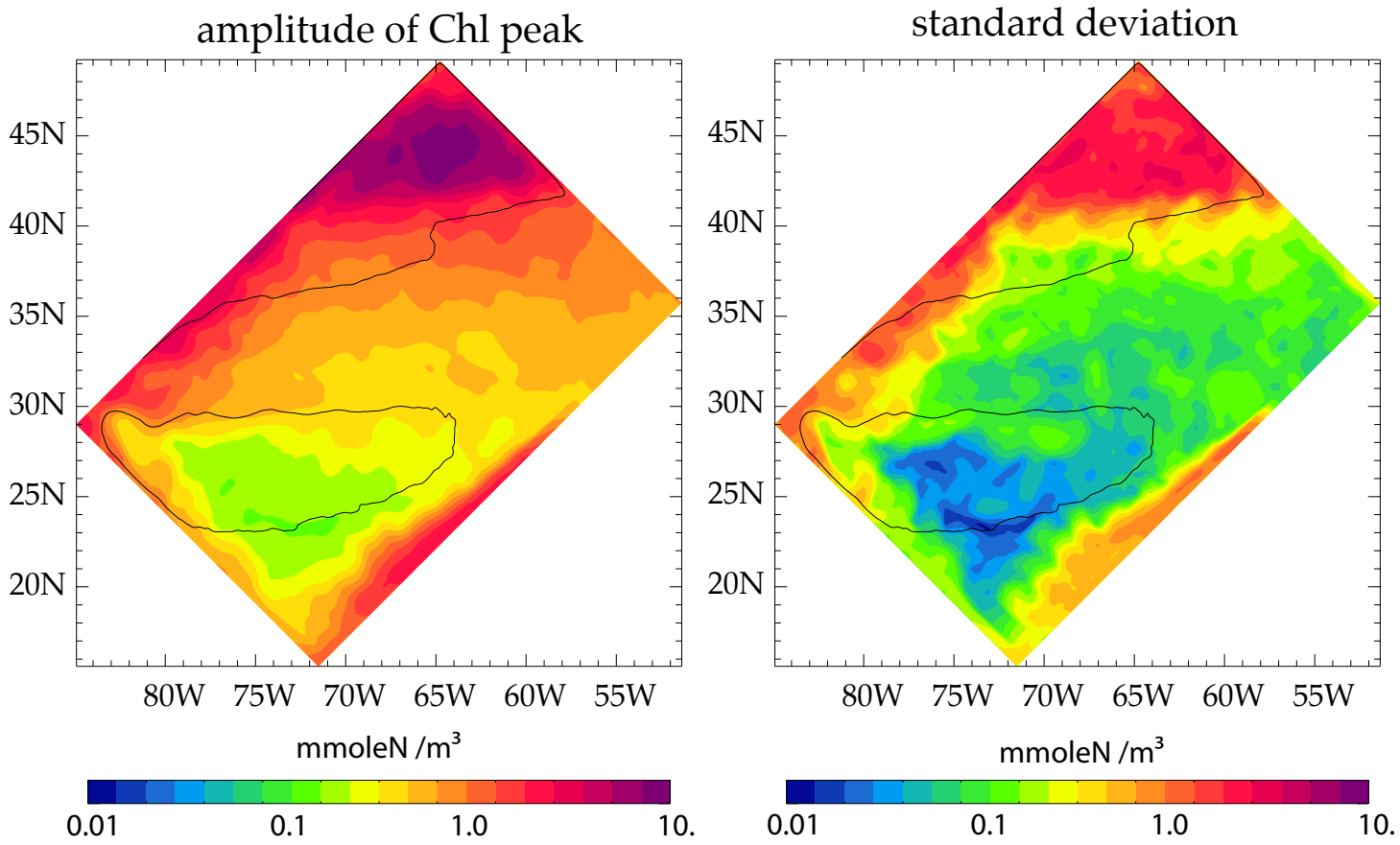
Chlorophyll

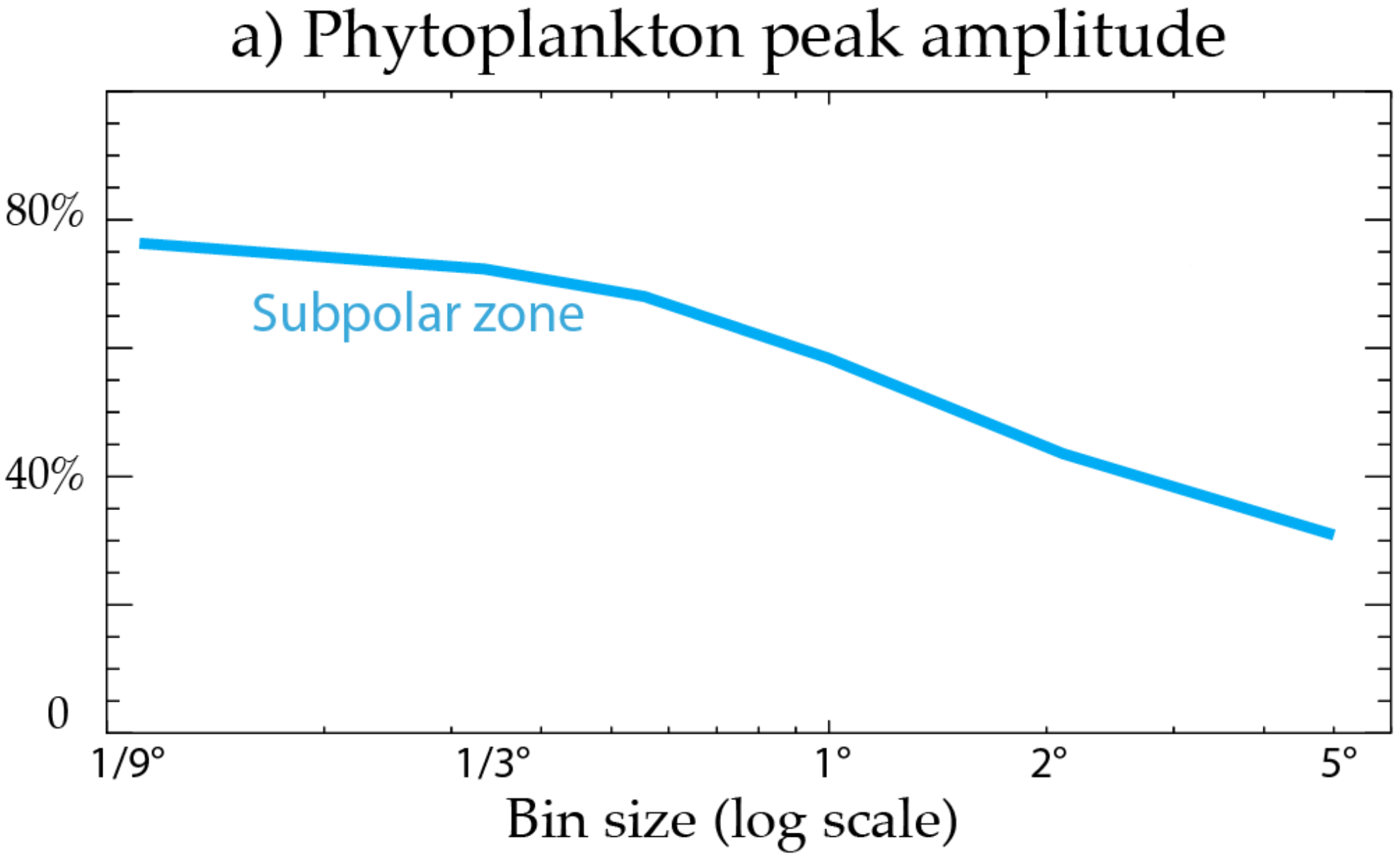


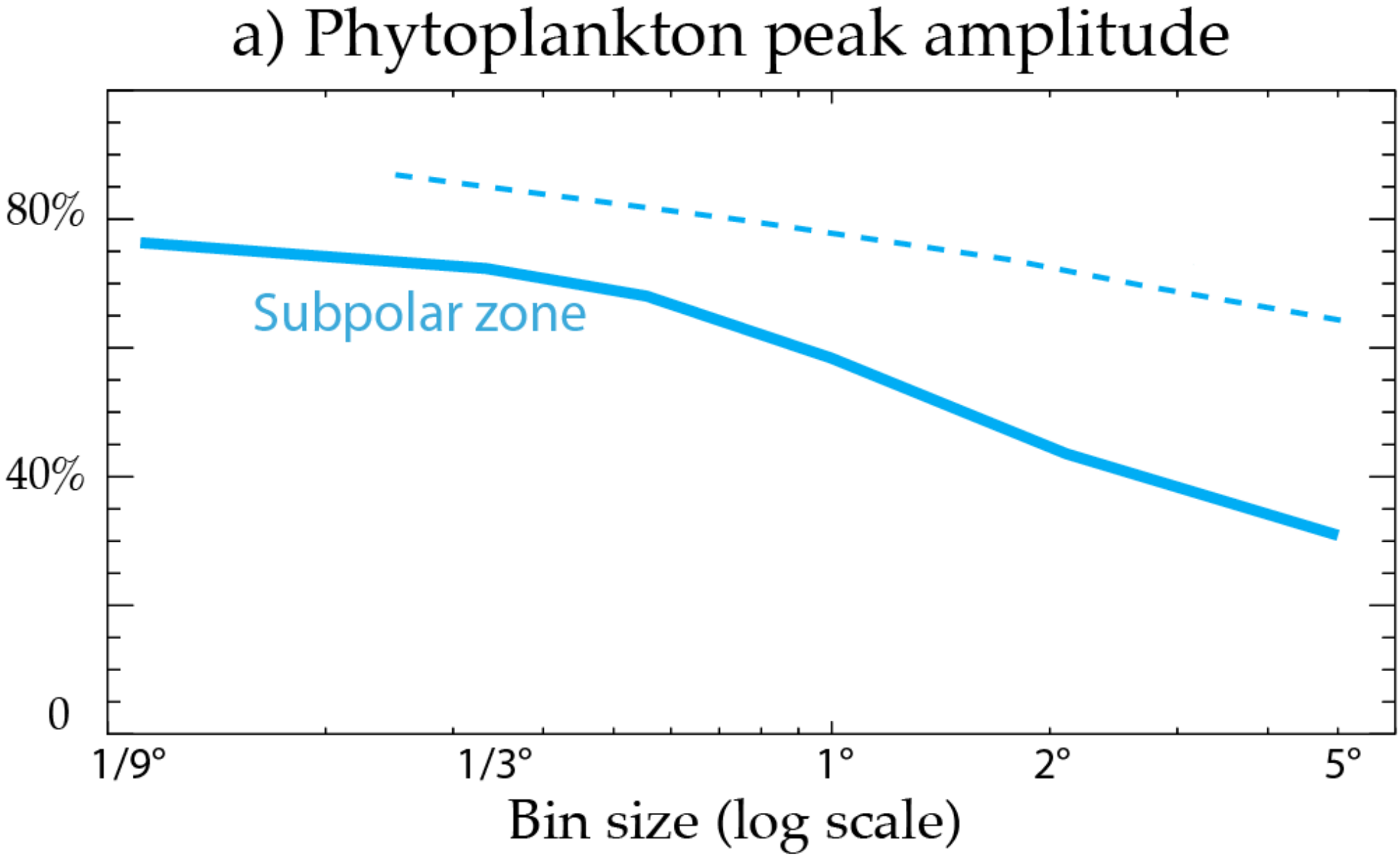
Bloom amplitude

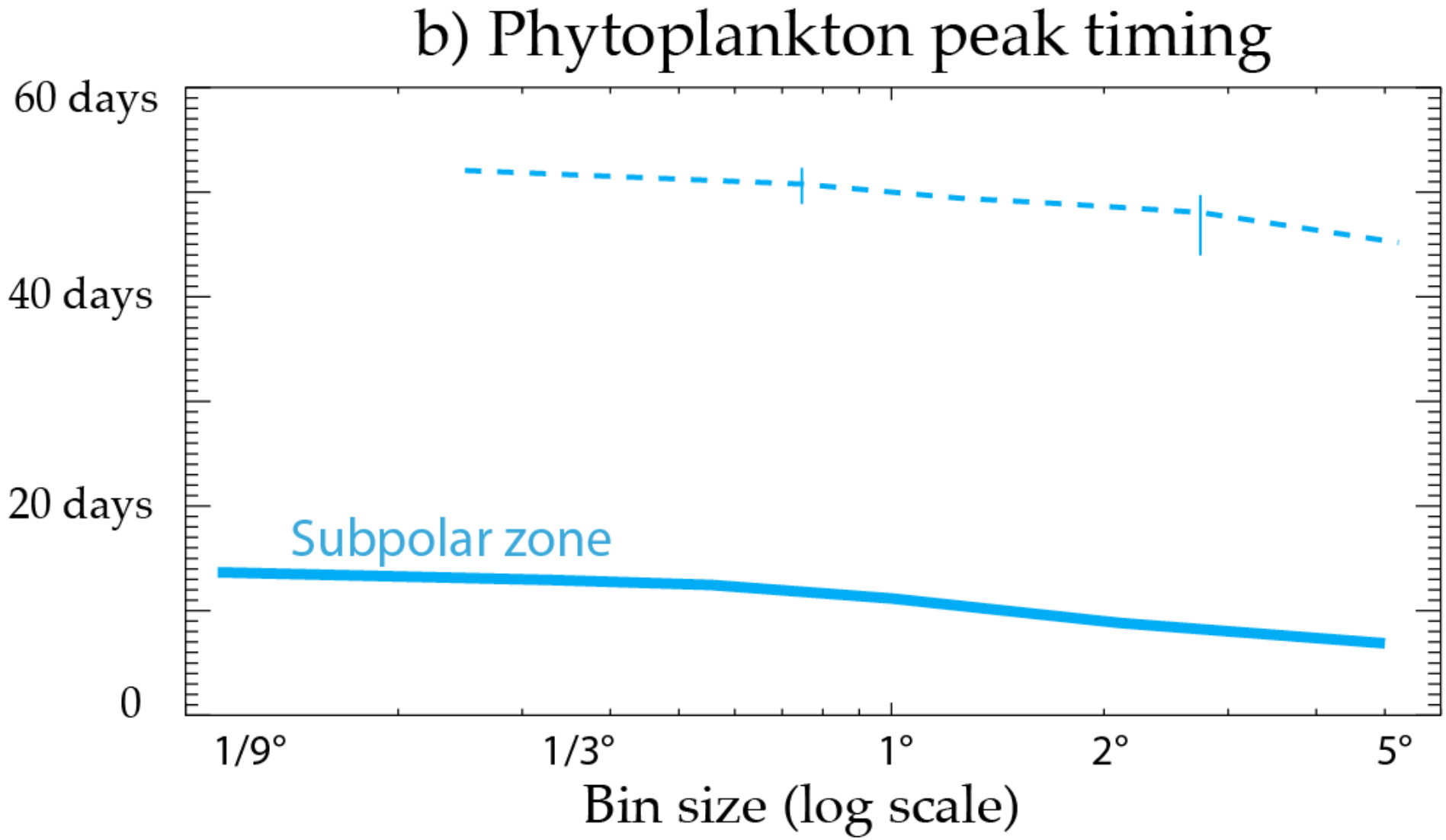



f) Year 1 to 5
120..
80.
40.
0.
F
M
A
M
J

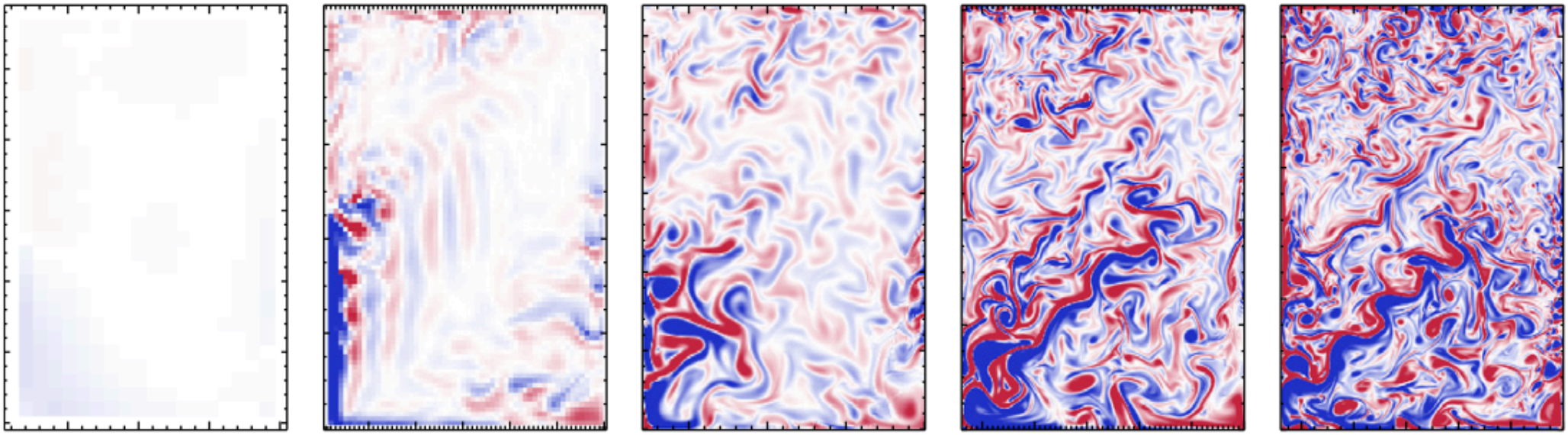

amplitude of Chl peak
standard deviation
45N
40N
35N
30N
25N
20N
80W
75W
70W
65W
60W
55W
mmoleN /m³
0.01
0.1
1.0
10.

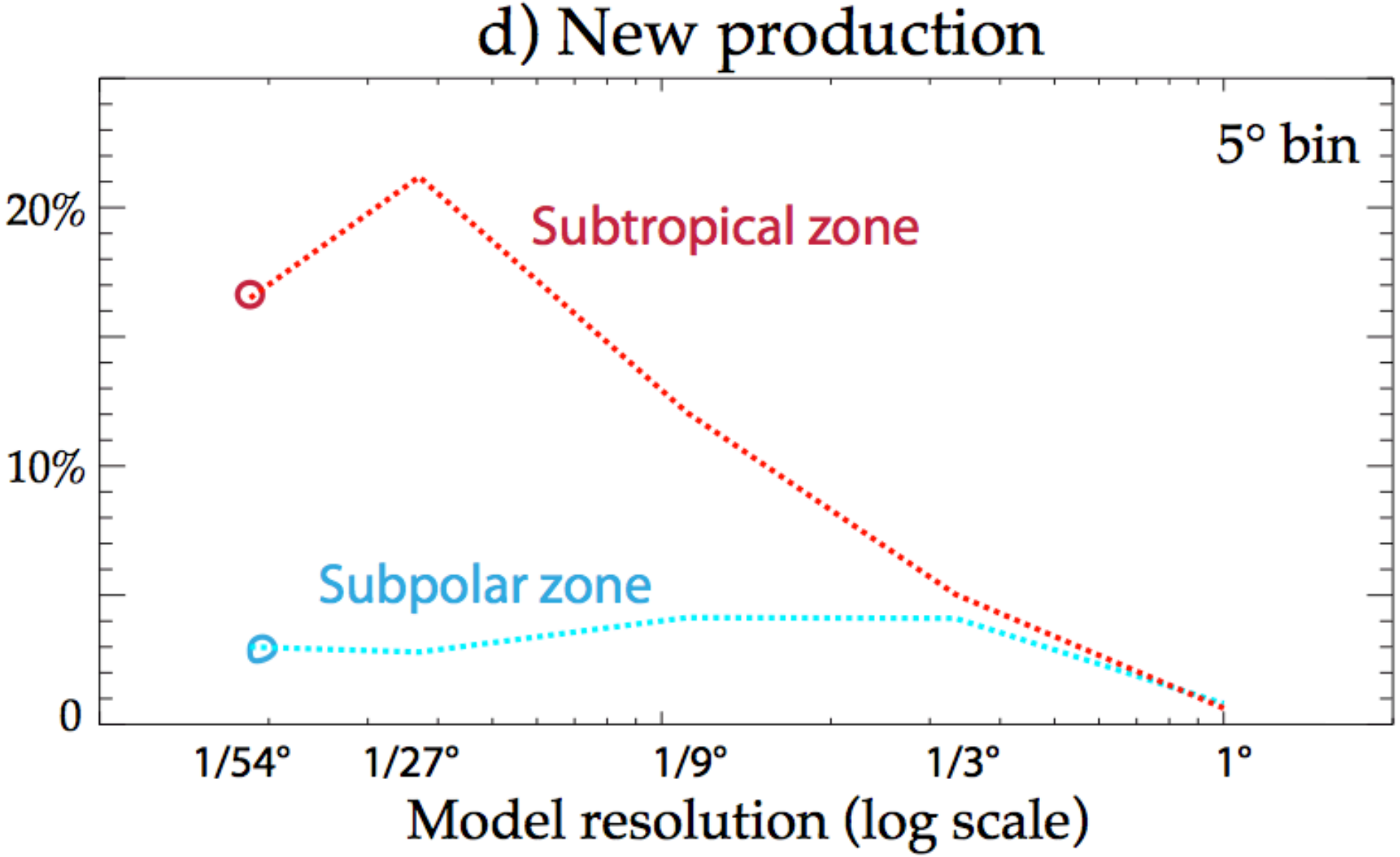

a) Phytoplankton peak amplitude
80%
40%
0
Subpolar zone
1/9°
1/3°
1°
2°
5°
Bin size (log scale)


a) Phytoplankton peak amplitude
80%
40%
0
Subpolar zone
1/9°
1/3°
1°
2°
5°
Bin size (log scale)


b) Phytoplankton peak timing
60 days
40 days
20 days
0
Subpolar zone
1/9°
1/3°
1°
2°
5°
Bin size (log scale)

Grid resolution




d) New production
5° bin
20%
10%
0
Subtropical zone
Subpolar zone
1/54°
1/27°
1/9°
1/3°
1°
Model resolution (log scale)

Conclusions

Analysis of internannual variability of ocean biogeochemical cycles, traditionally based on coarse resolution model and/or data might forget an important internal source of variability

Using time series data at fixed stations to examine internannual variability is highly hazardous

Earth system models: Need to go to HR not only to imporve the mean state but also the variability