2014 Annual Meeting

S7: Recent assessments of climate change impacts on marine ecosystems

Plankton in a changing climate: coastal and polar cases study

Hongjun SONG

(The First Institute of Oceanography, SOA, Qingdao, China,

E-mail: songhongjun@fio.org.cn)

Rubao Ji

(Woods Hole Oceanographic Institution, Woods Hole, MA, USA)

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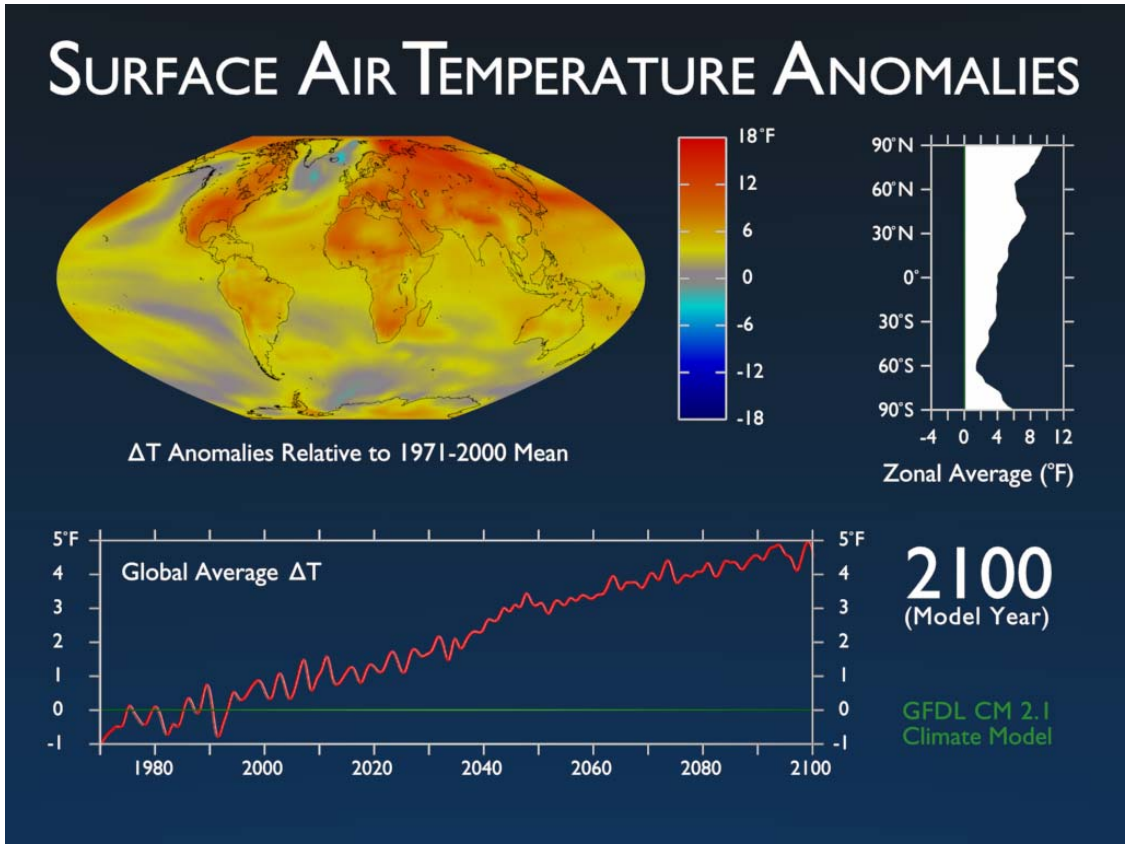
Outline

- Background
- Coastal Case
- Polar Case
- Future Work

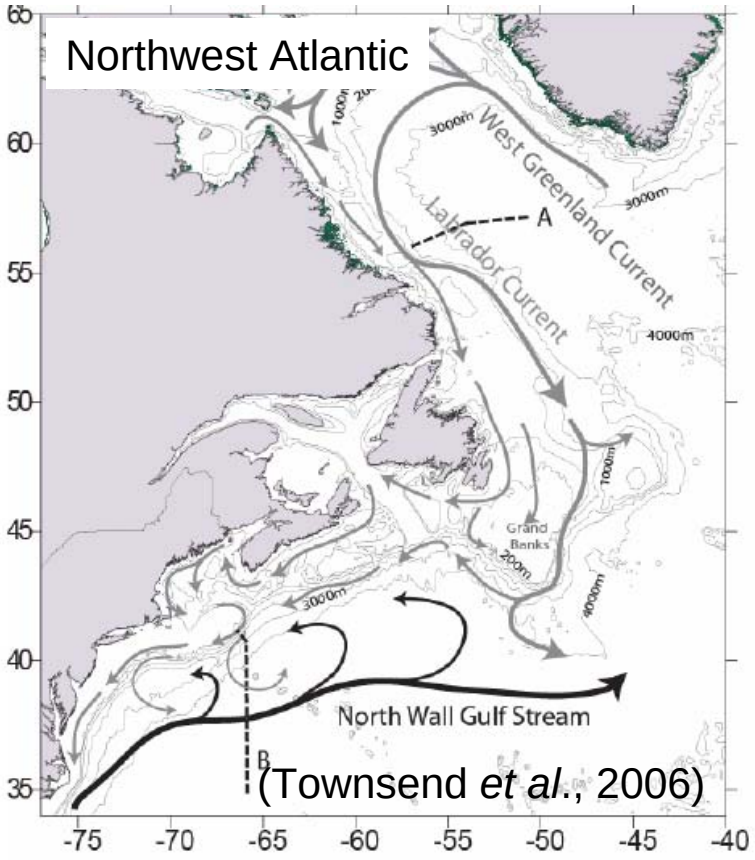
Background

The climate is changing!

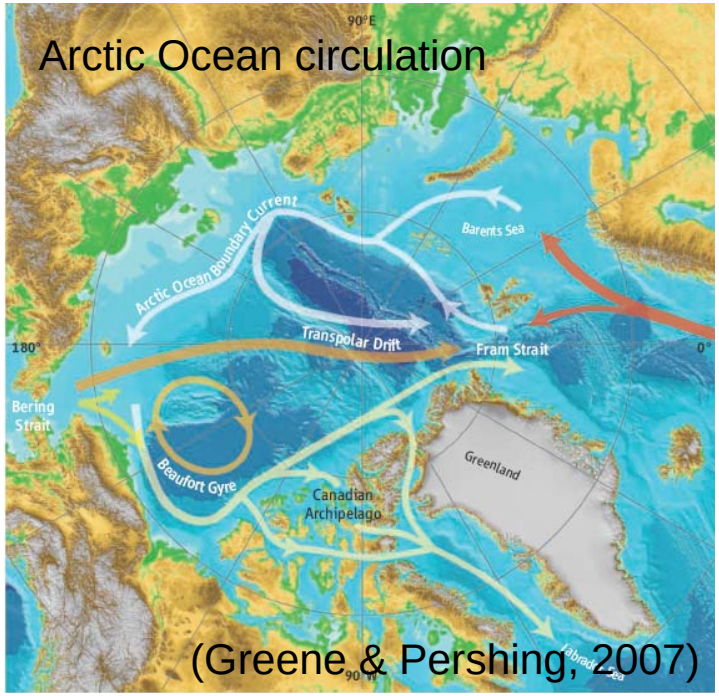
Global Warming



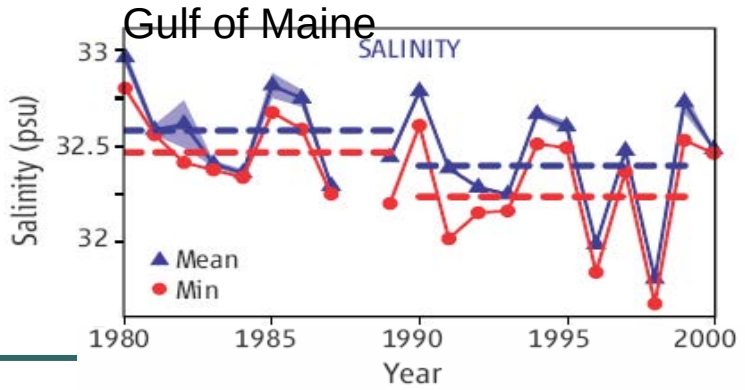
Climate drives sea change!



(Townsend *et al*., 2006)

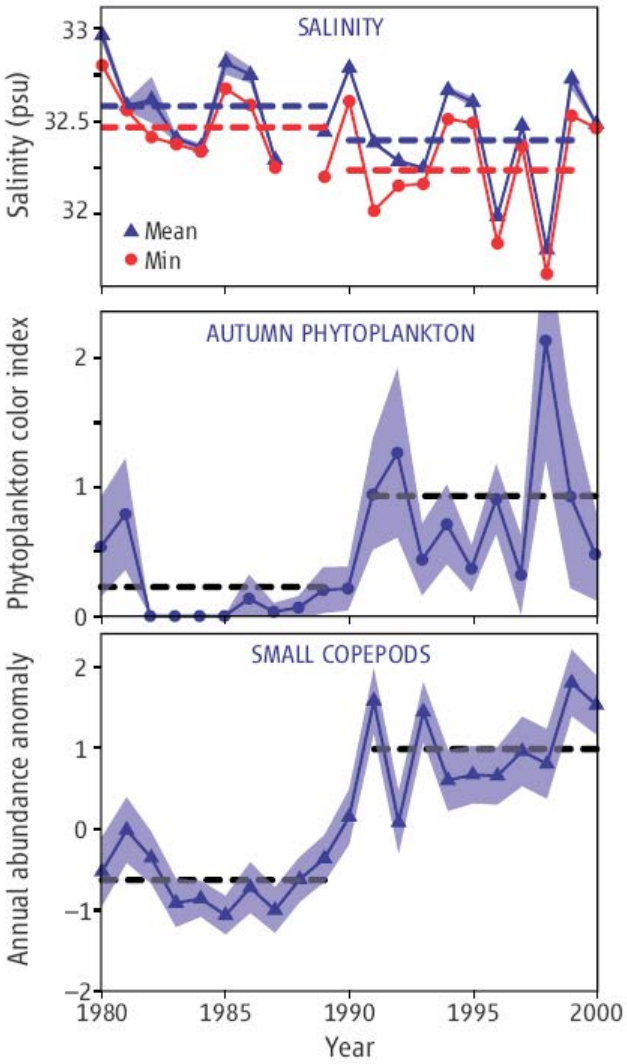


(Greene & Pershing, 2007)

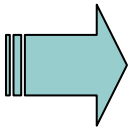


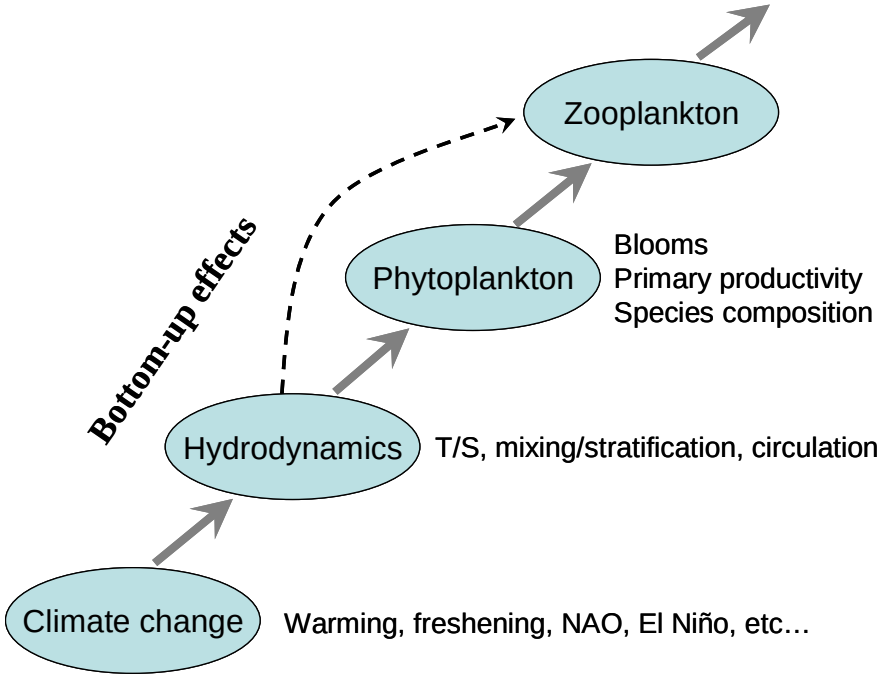
(Greene & Pershing, 2007)

Gulf of Maine

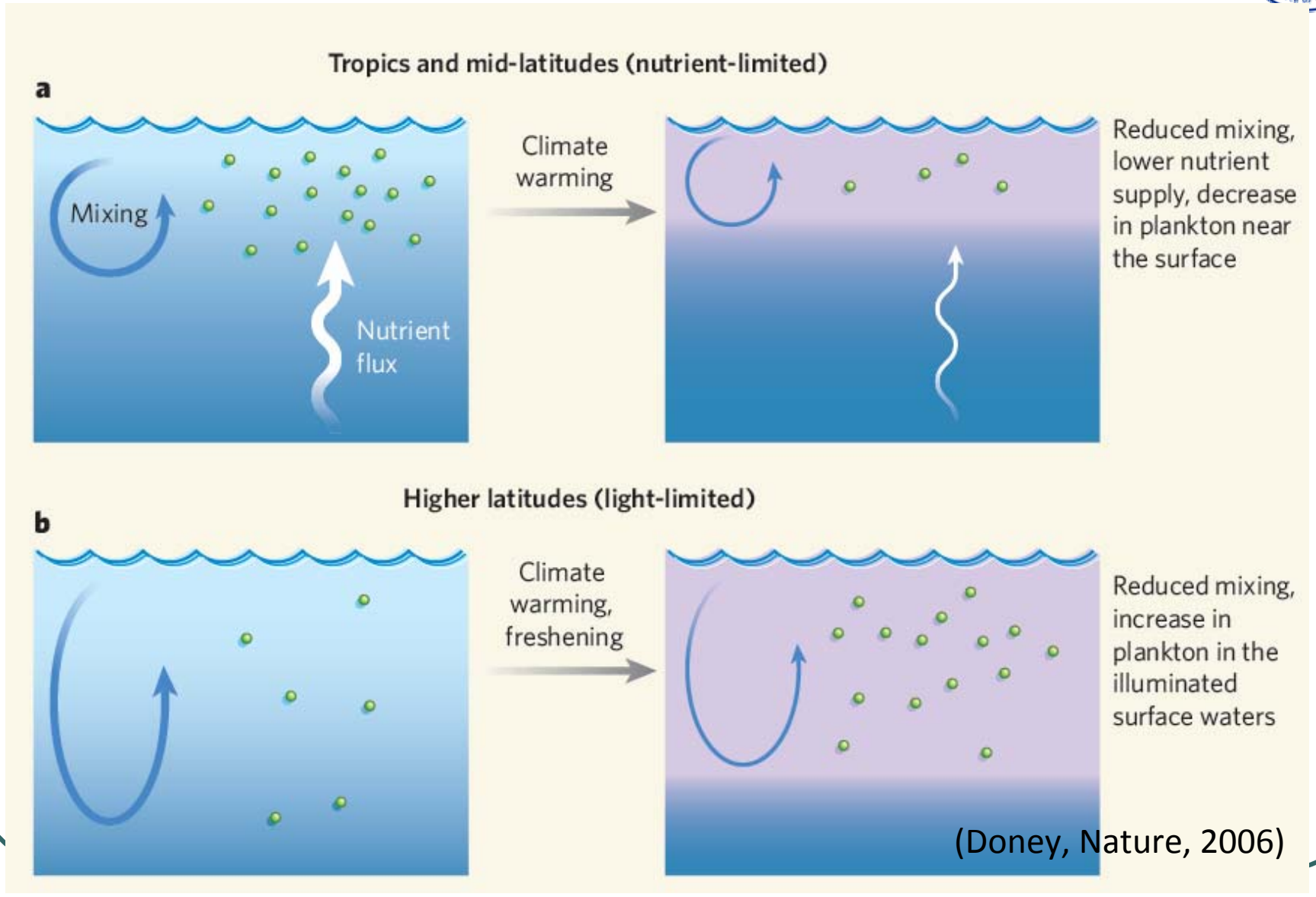


(Greene & Pershing, 2007)





sketch map



(Doney, Nature, 2006)

Phytoplankton

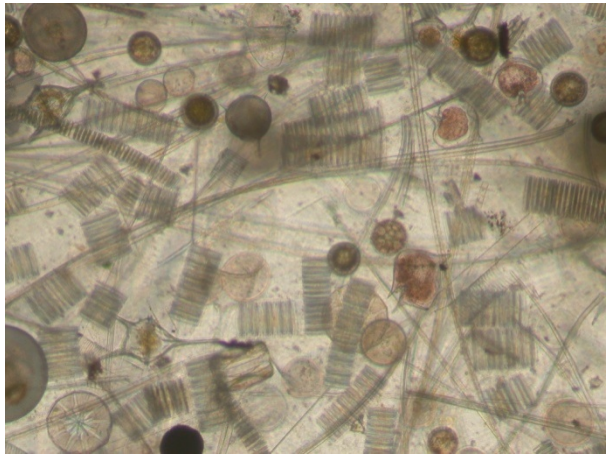
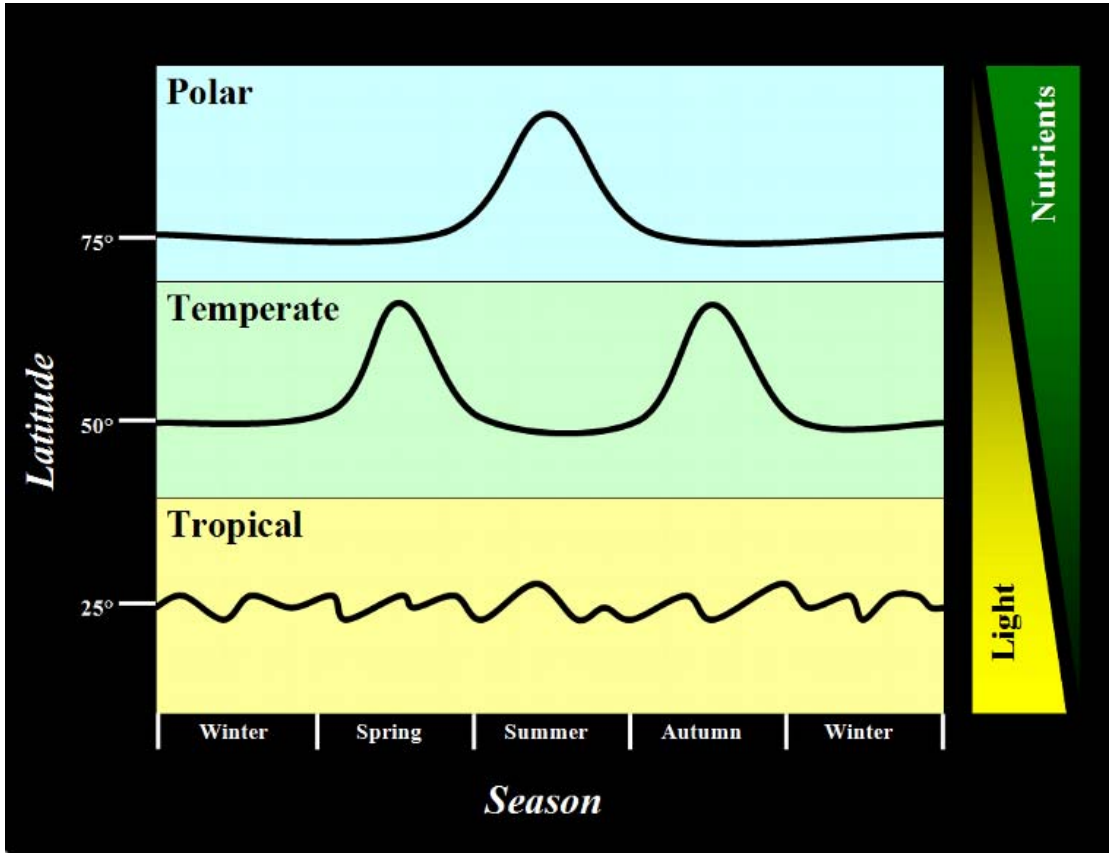


Photo of a live marine plankton sample (x400 magnification). Photo L. Armand.

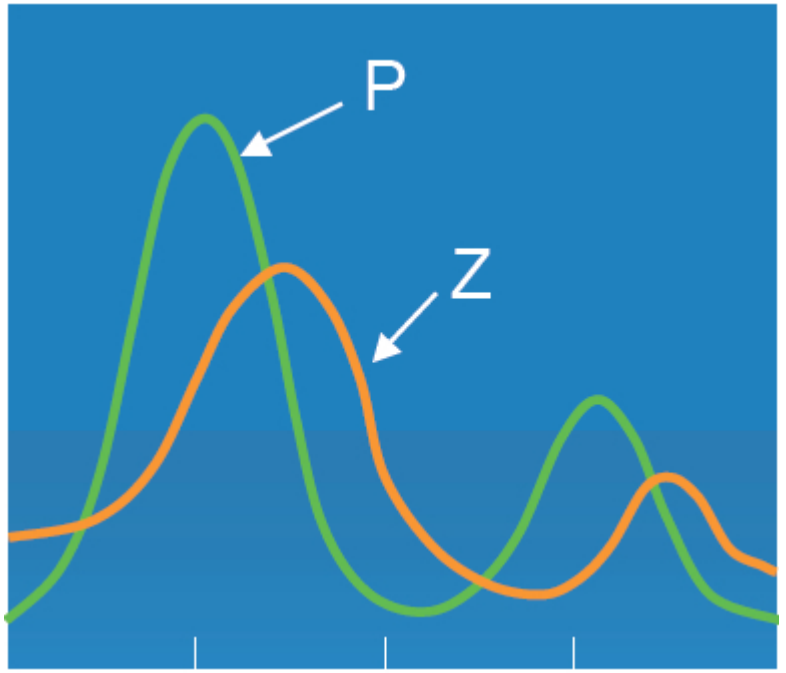
Common marine phytoplankton

Phytoplankton bloom



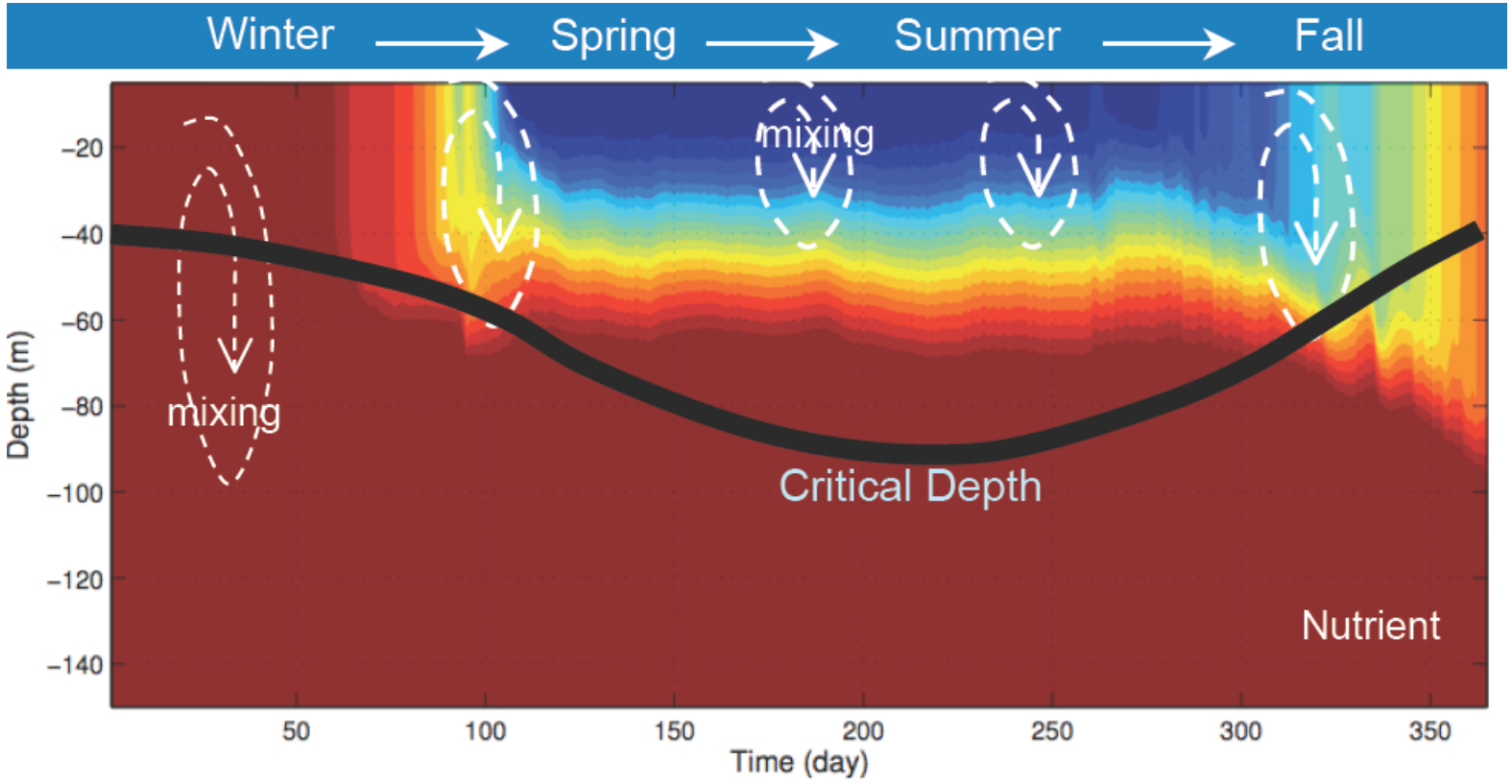
www.marineodyssey.co.uk

Zooplankton

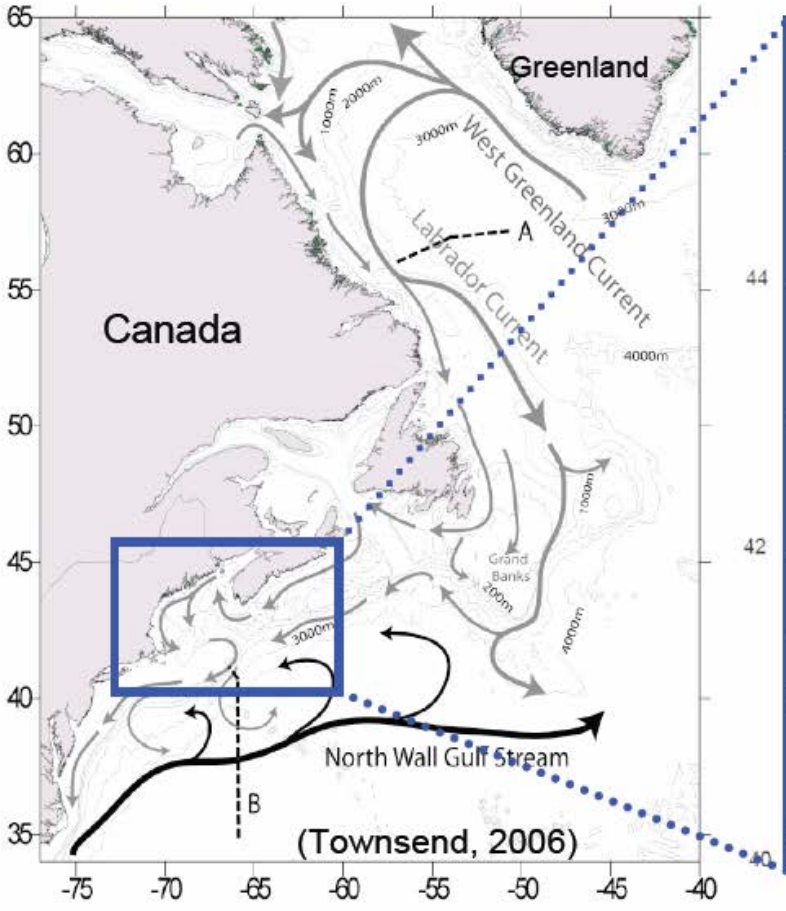


Coastal Cases

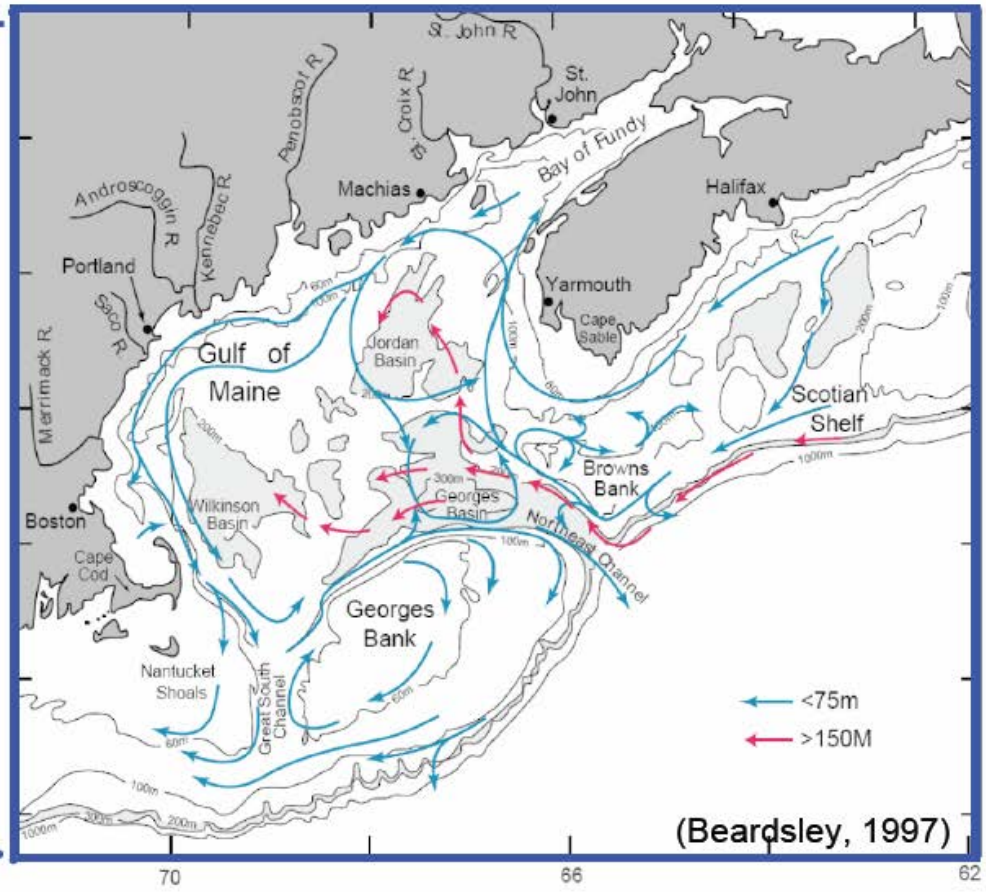
Conceptual model (temperate region):



Northwest Atlantic

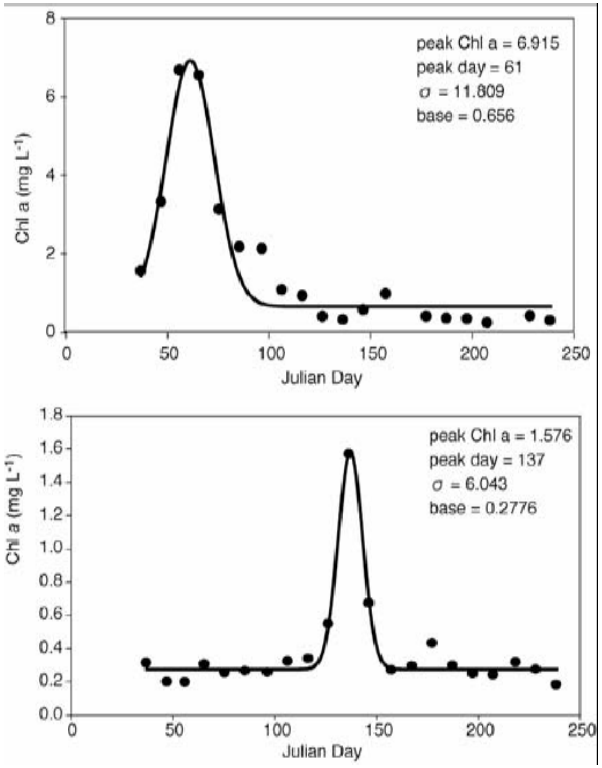


Gulf of Maine - Georges Bank



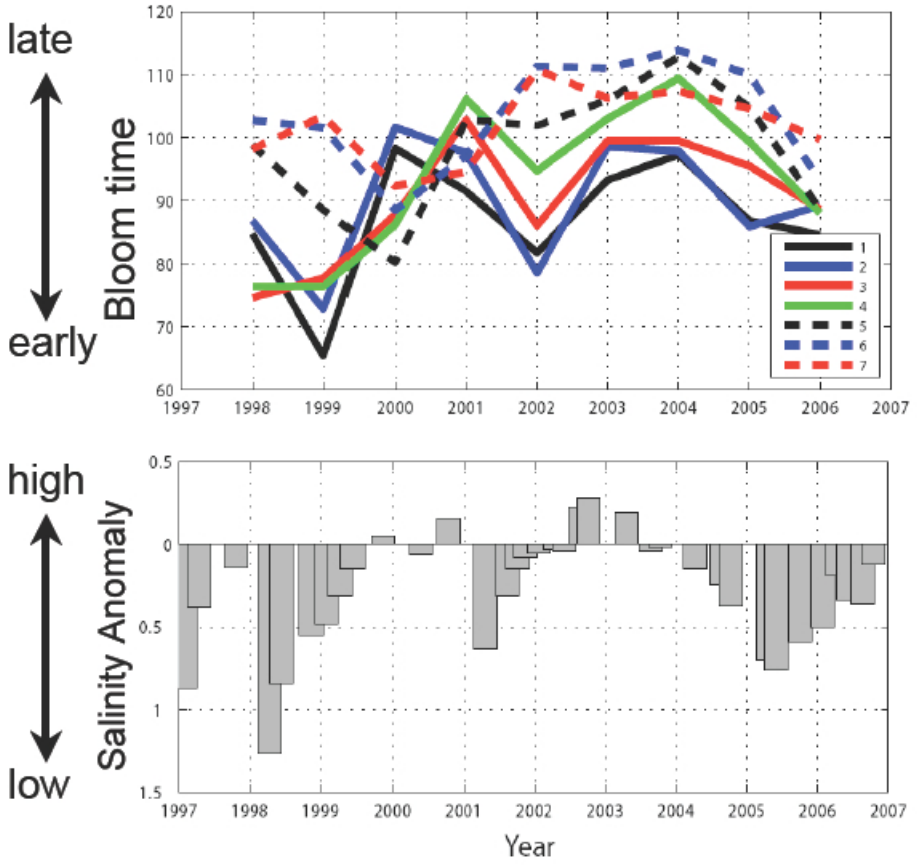
Remote sensing

Gaussian curve fit



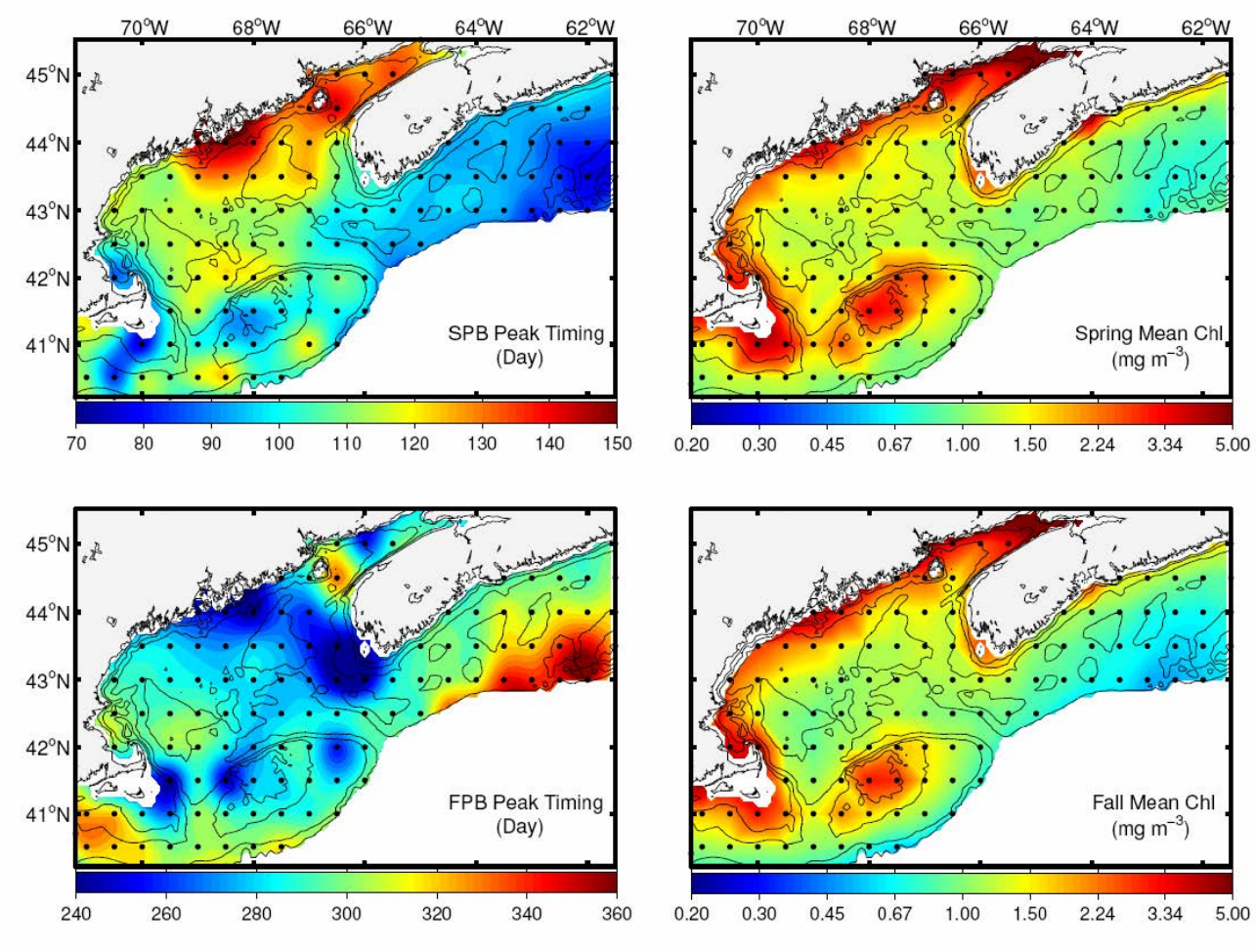
(Chiba & Sasaoka, 2007)

Bloom timing inter-annual variability

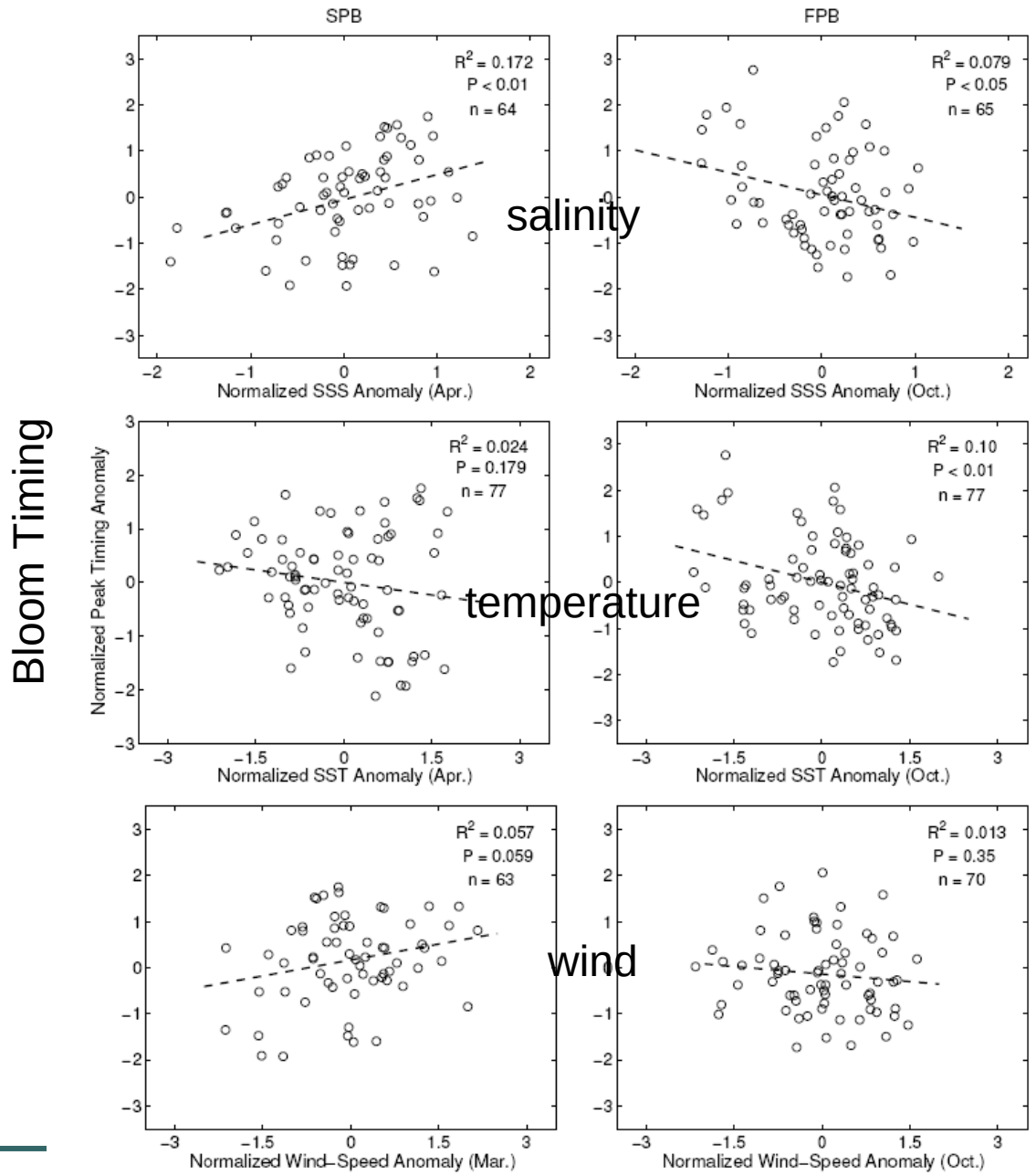


(Ji *et al*., 2007)

Spatial distribution

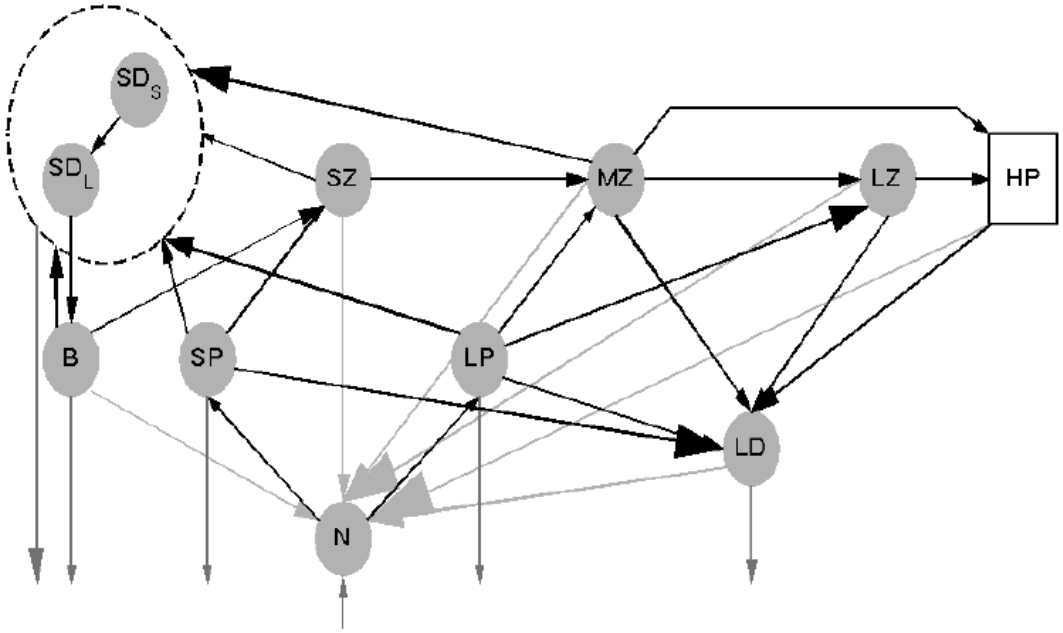


(Song *et al.*, JPR, 2010)

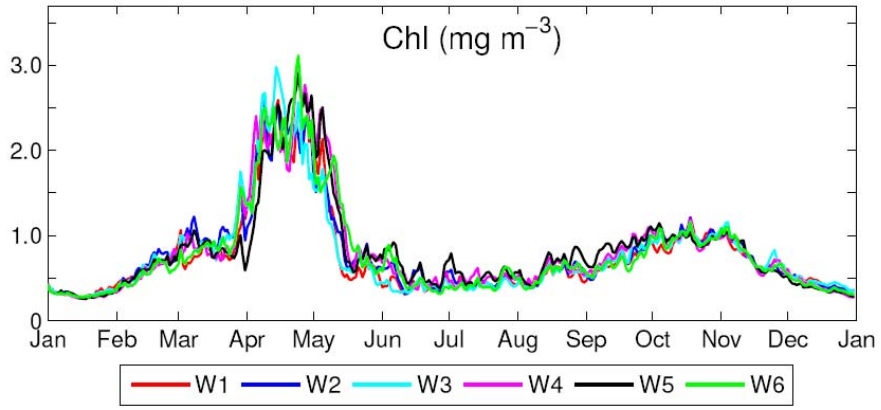

SPB
FPB
R^2 = 0.172
P < 0.01
n = 64
R^2 = 0.079
P < 0.05
n = 65
Normalized SSS Anomaly (Apr.)
Normalized SSS Anomaly (Oct.)
salinity
Bloom Timing
Normalized Peak Timing Anomaly
R^2 = 0.024
P = 0.179
n = 77
R^2 = 0.10
P < 0.01
n = 77
Normalized SST Anomaly (Apr.)
Normalized SST Anomaly (Oct.)
temperature
R^2 = 0.057
P = 0.059
n = 63
R^2 = 0.013
P = 0.35
n = 70
Normalized Wind–Speed Anomaly (Mar.)
Normalized Wind–Speed Anomaly (Oct.)
wind
Spring
Fall

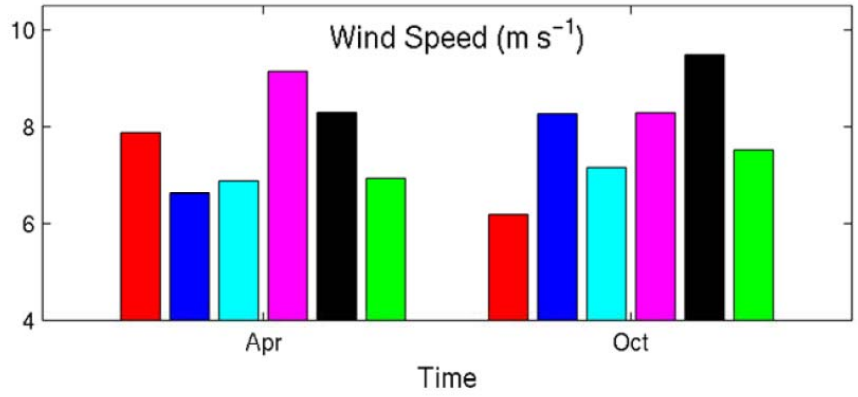
Ecosystem modeling

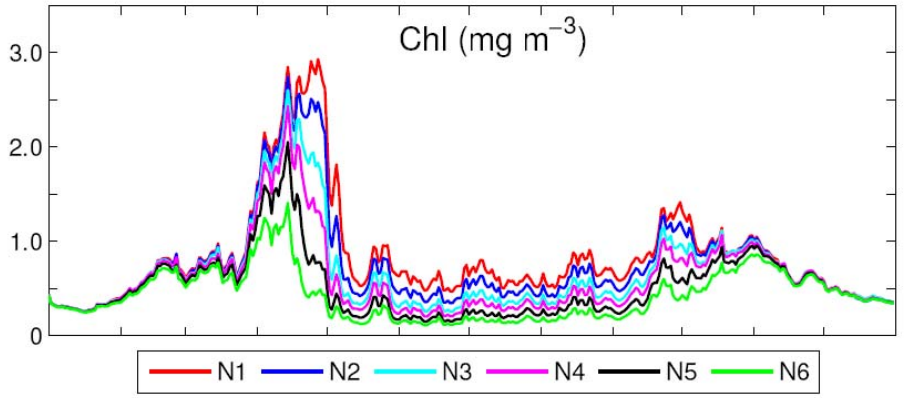
Ecosystem model structure (Stock & Dunne, 2010).

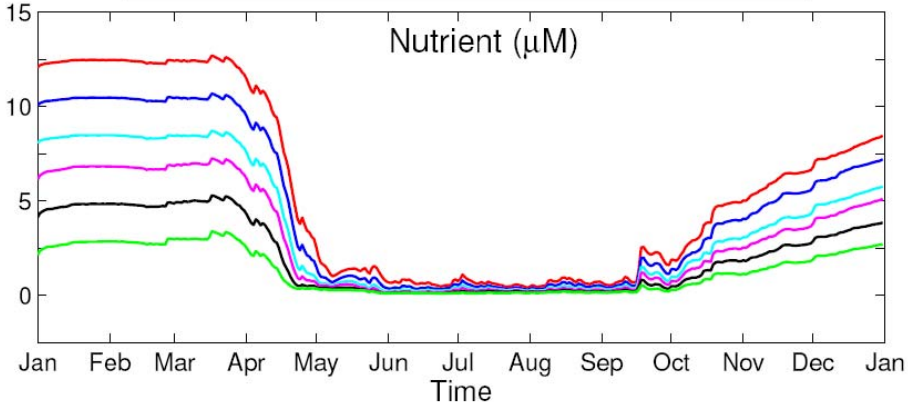


Single factor experiments



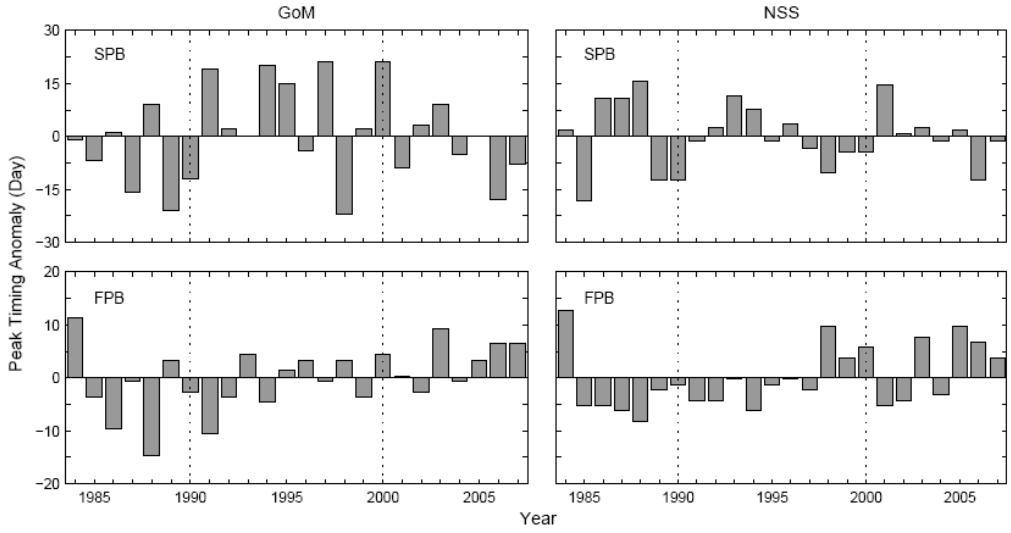




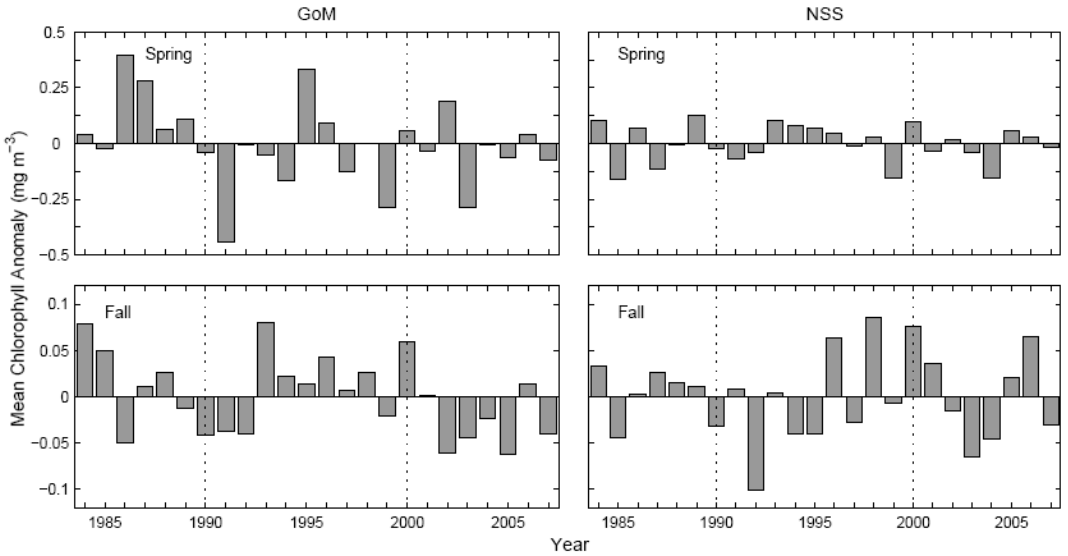


Inter-annual variability (Song et al., MEPS, 2011)

timing

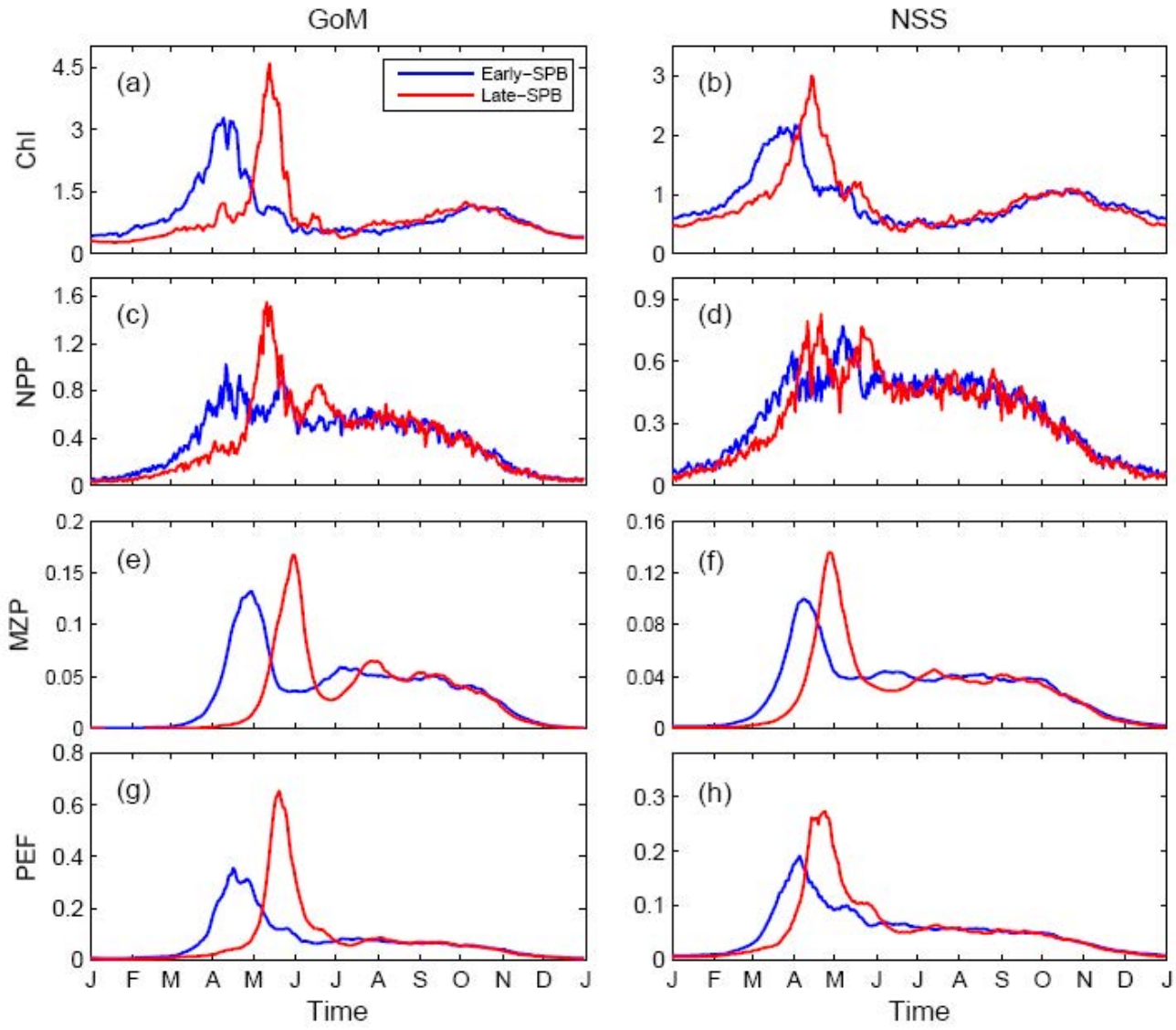


magnitude

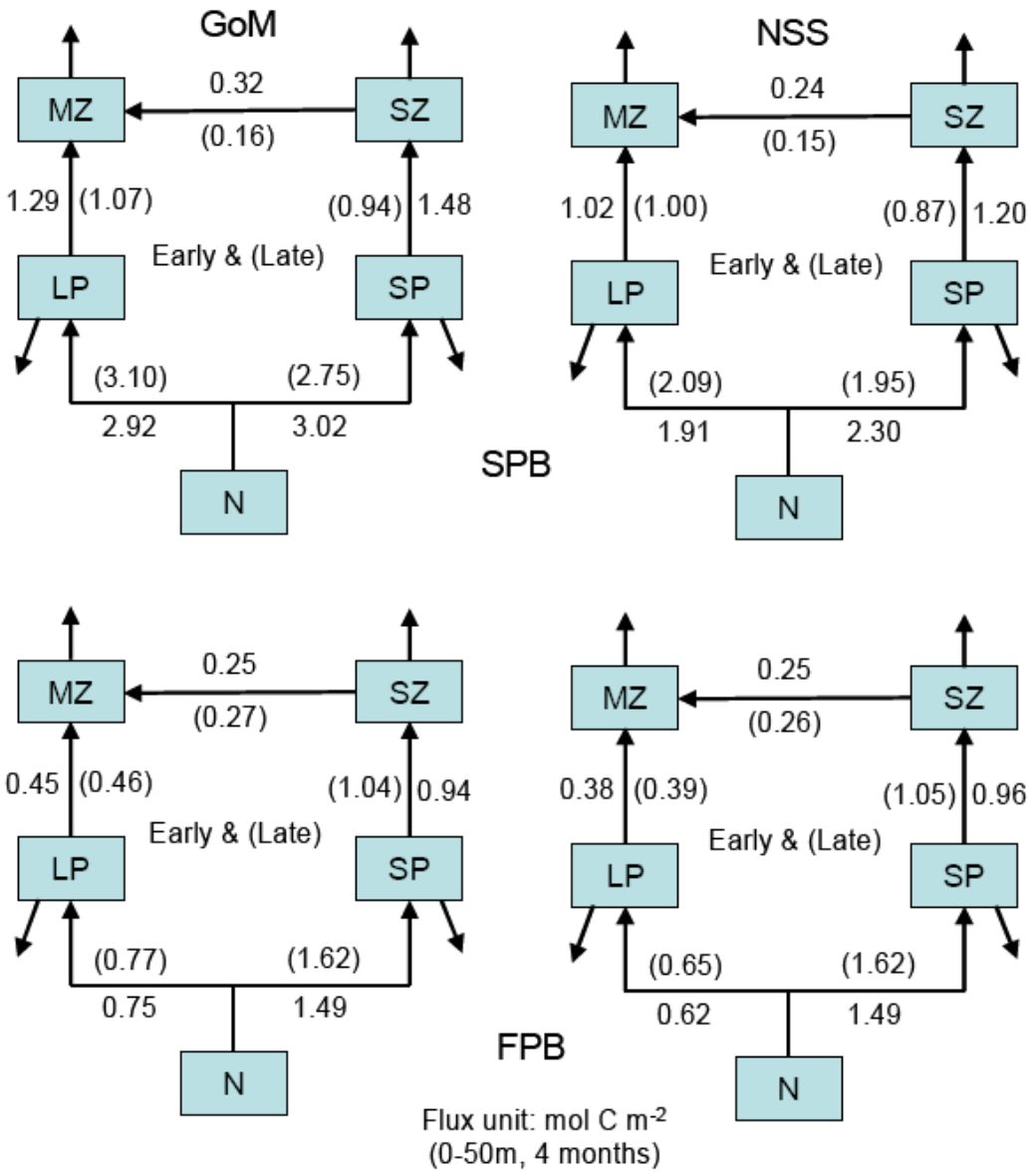


1984-2007

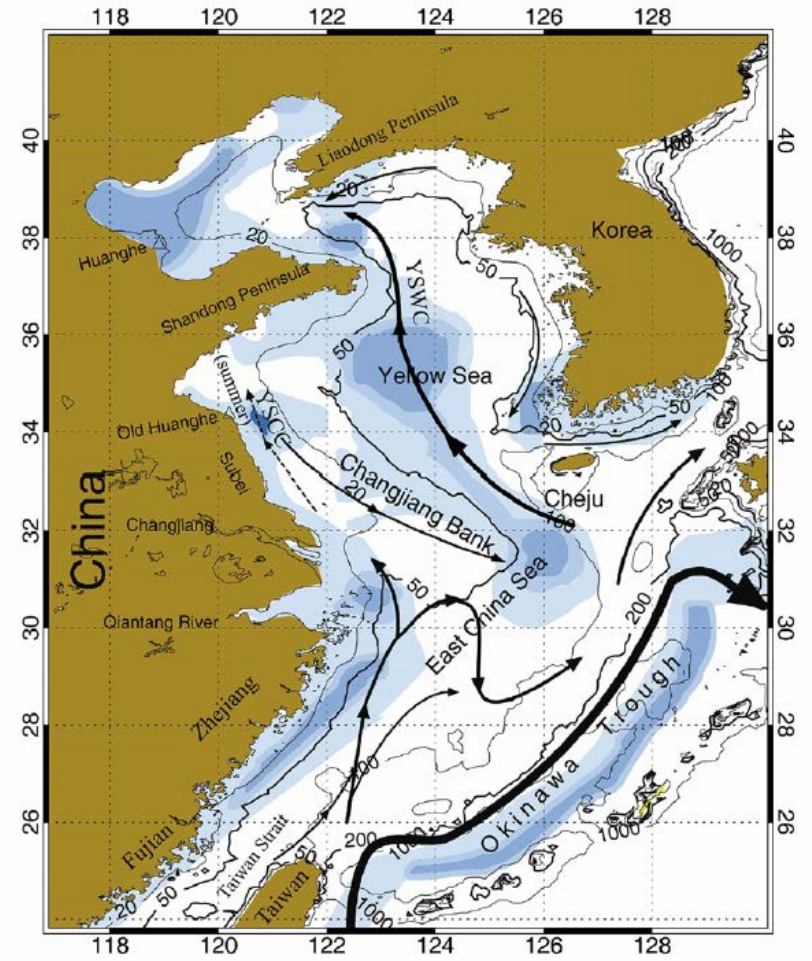
SPB timing & chlorophyll, primary production, meso-zooplankton production, particle export flux



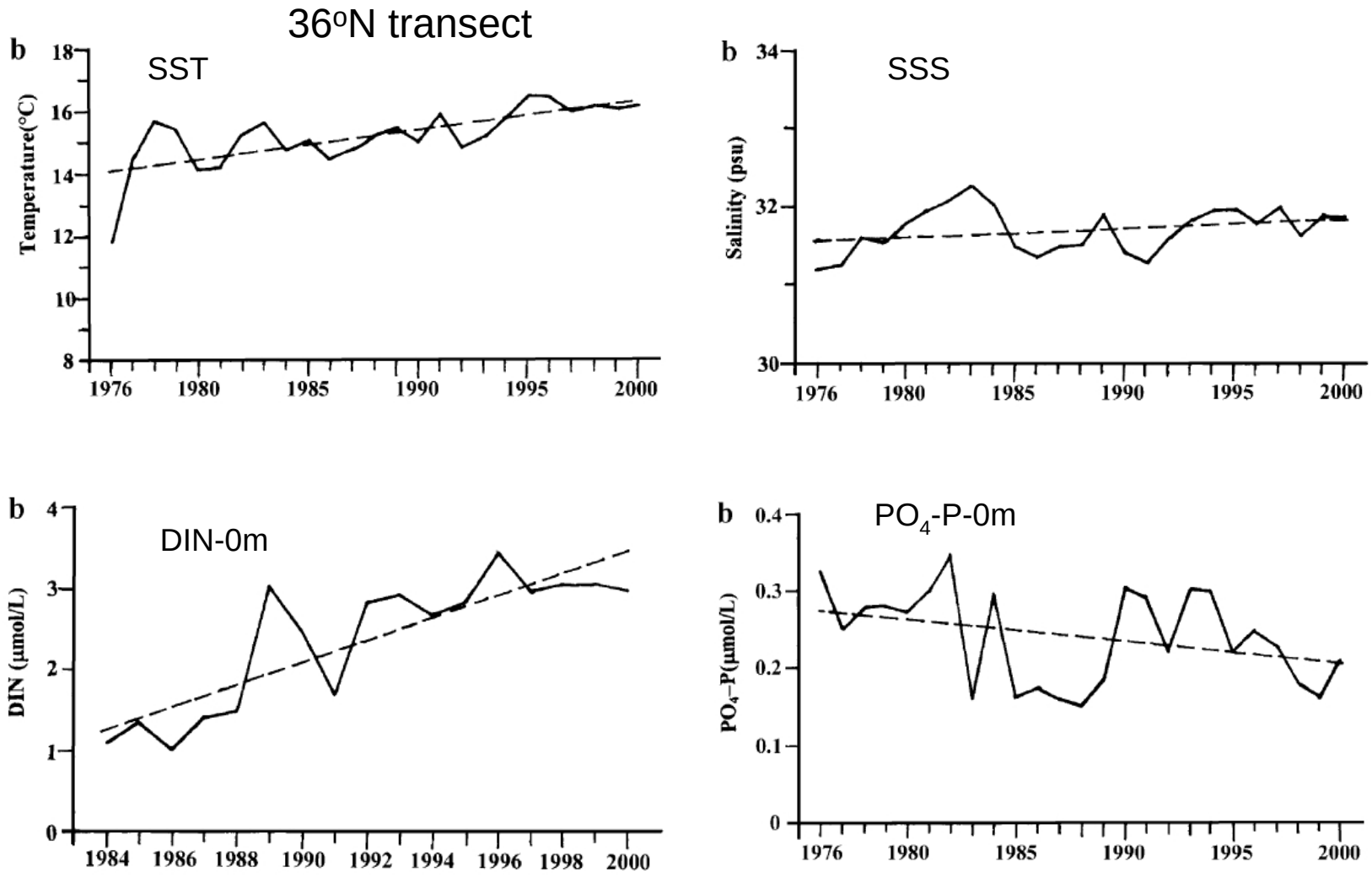
Energy flow


GoM
MZ
SZ
0.32
(0.16)
1.29
(1.07)
(0.94)
1.48
Early & (Late)
LP
SP
(3.10)
(2.75)
2.92
3.02
N
NSS
MZ
SZ
0.24
(0.15)
1.02
(1.00)
(0.87)
1.20
Early & (Late)
LP
SP
(2.09)
(1.95)
1.91
2.30
N
SPB
MZ
SZ
0.25
(0.27)
0.45
(0.46)
(1.04)
0.94
Early & (Late)
LP
SP
(0.77)
(1.62)
0.75
1.49
N
MZ
SZ
0.25
(0.26)
0.38
(0.39)
(1.05)
0.96
Early & (Late)
LP
SP
(0.65)
(1.62)
0.62
1.49
N
FPB
Flux unit: mol C m-2
(0-50m, 4 months)

Yellow Sea

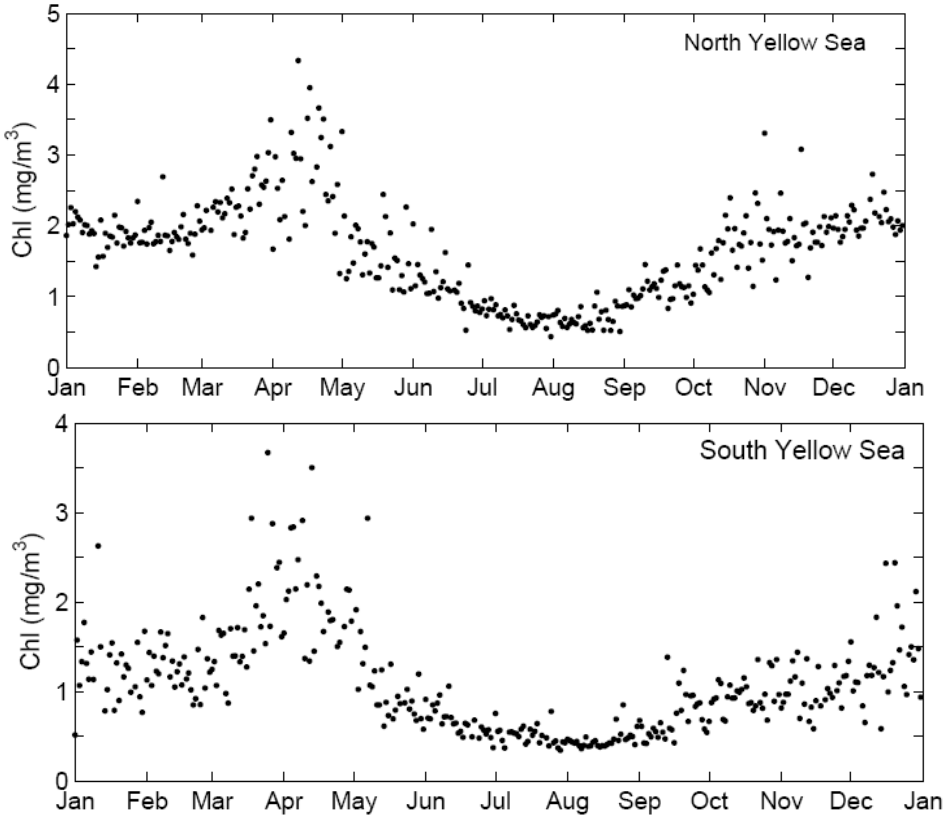

Liaodong Peninsula
Korea
Huanghe
Shandong Peninsula
YSWC
Yellow Sea
(summer)
YSCC
Old Huanghe
Subei
China
Changjiang
Changjiang Bank
Cheju
East China Sea
Qiantang River
Zhejiang
Fujian
Taiwan Strait
Taiwan
Okinawa
Trough
118
120
122
124
126
128
40
38
36
34
32
30
28
26
20
50
100
200
1000

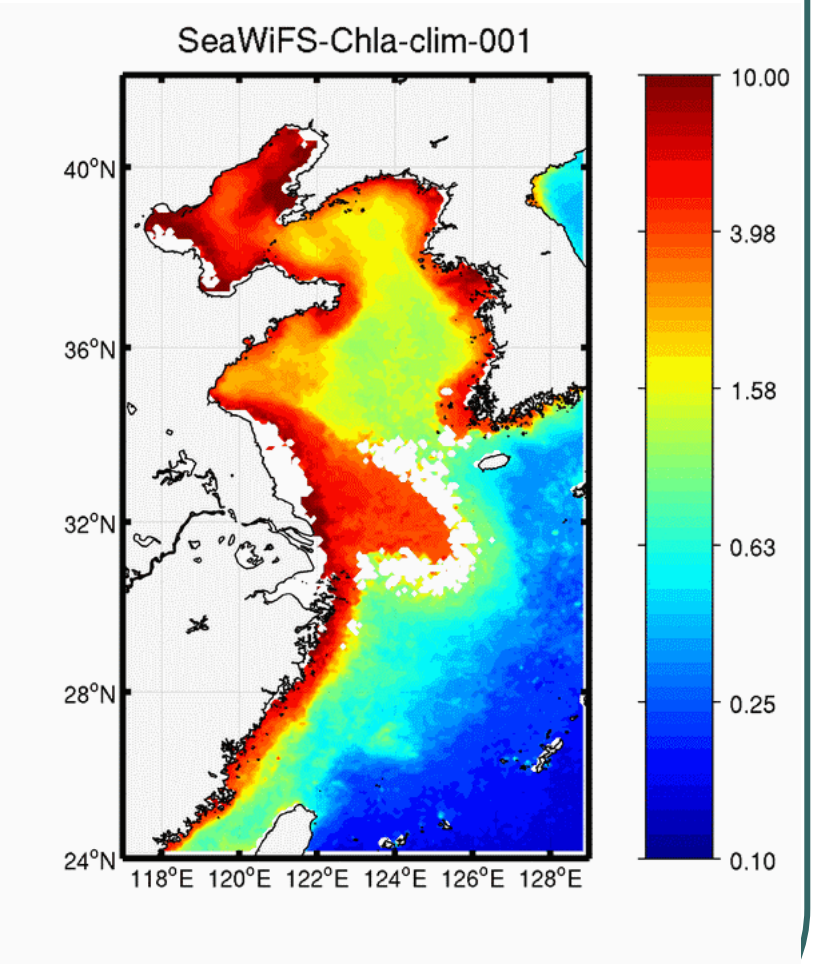
Long-term variability



(Lin *et al*., 2005, JMS)

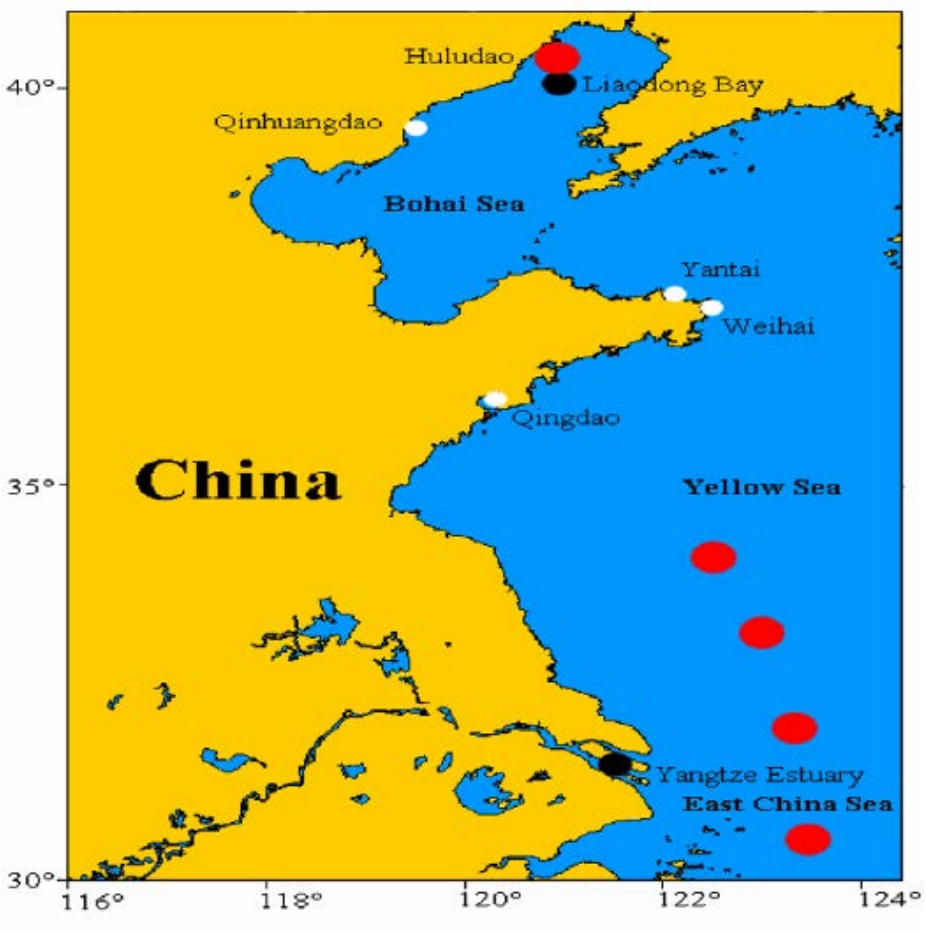
Phytoplankton dynamics in central YS





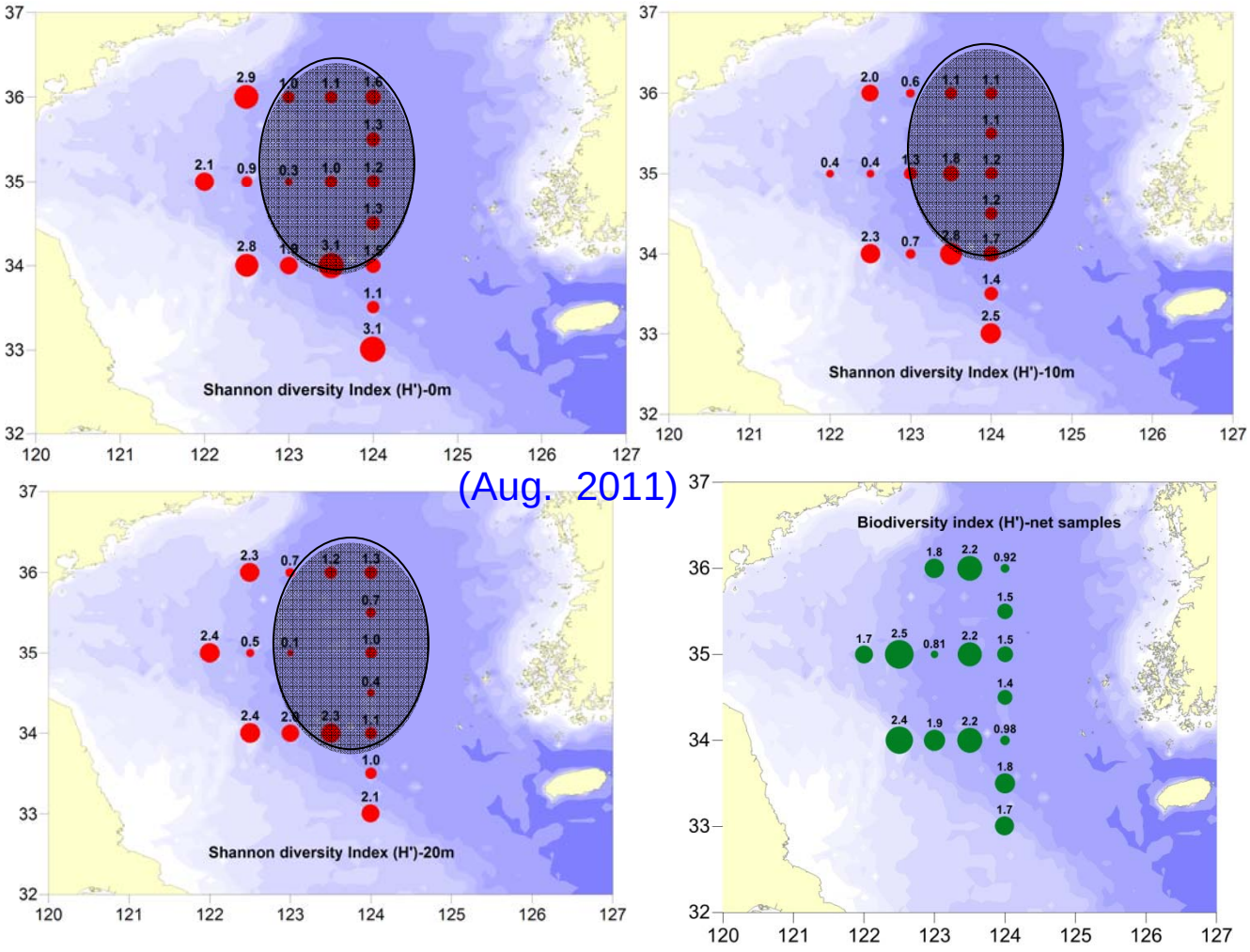
SeaWiFS Climatology data

Jellyfish Blooms



(Dong *et al.*, 2010)

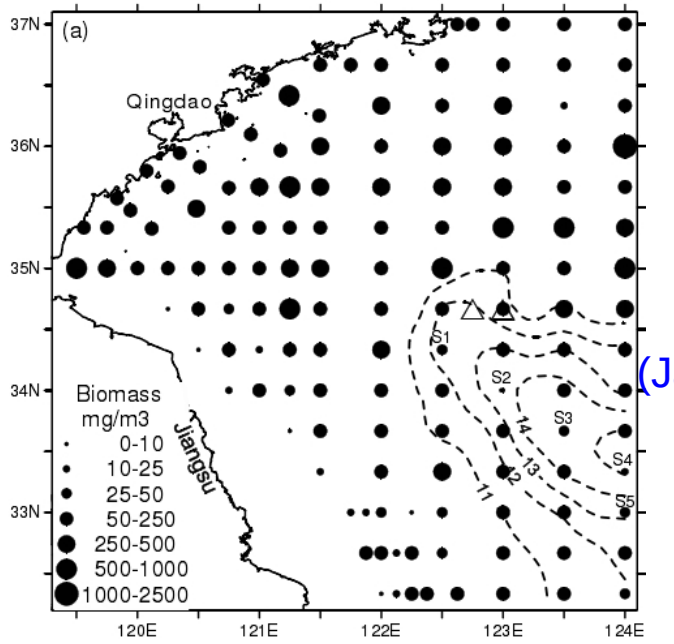
Phytoplankton Diversity & YS Cold Water Mass



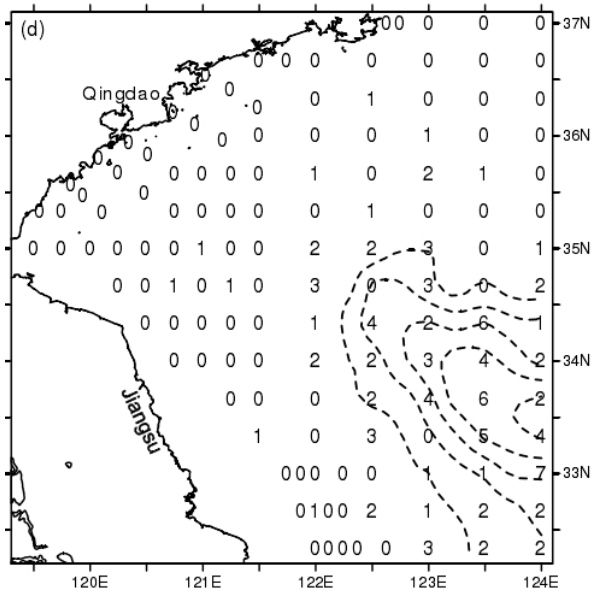
(Aug. 2011)

- Relatively lower diversity in the central part of YSCWM;
- Simple phytoplankton community.

Zooplankton distribution & Yellow Sea Warm Current

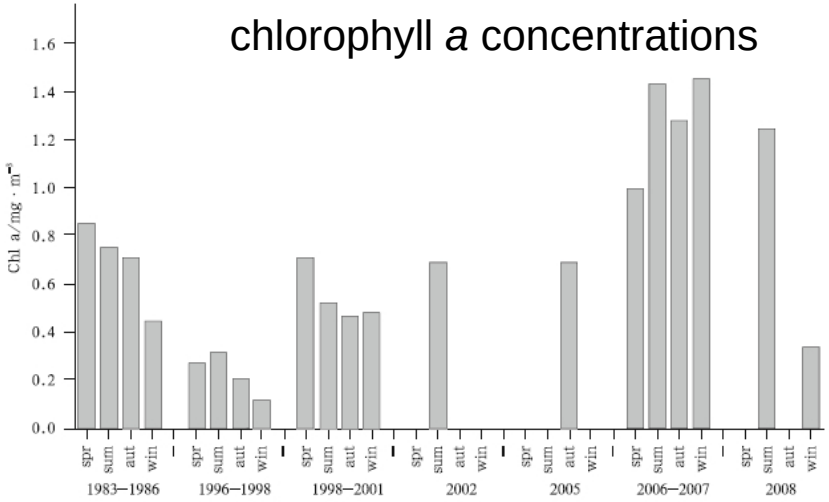


(Jan. 2007)

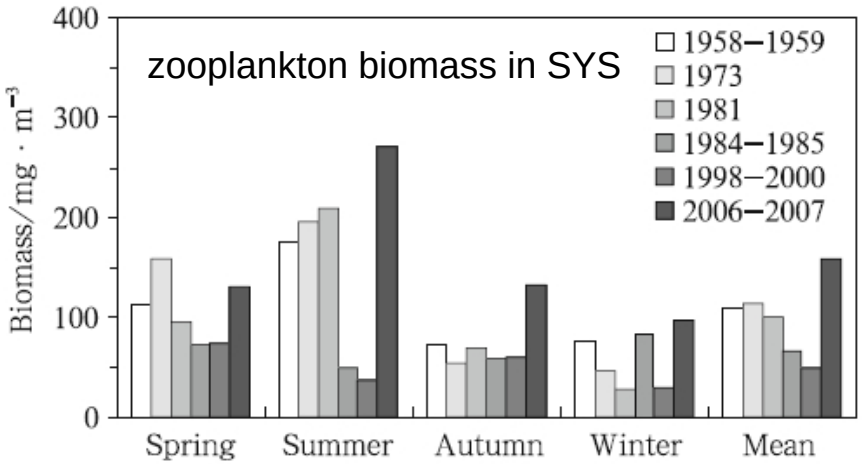


- Low zooplankton biomass in the YSWC area;
- YSWC advected tropical species of zooplankton into the southern YS

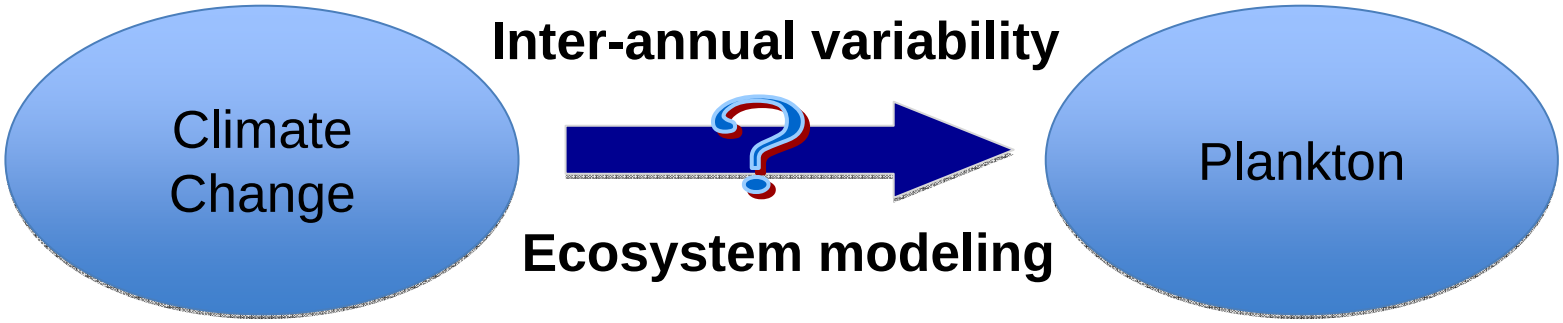
Long-term variability



(Fu *et al*., 2012)



(Liu *et al*., 2012)

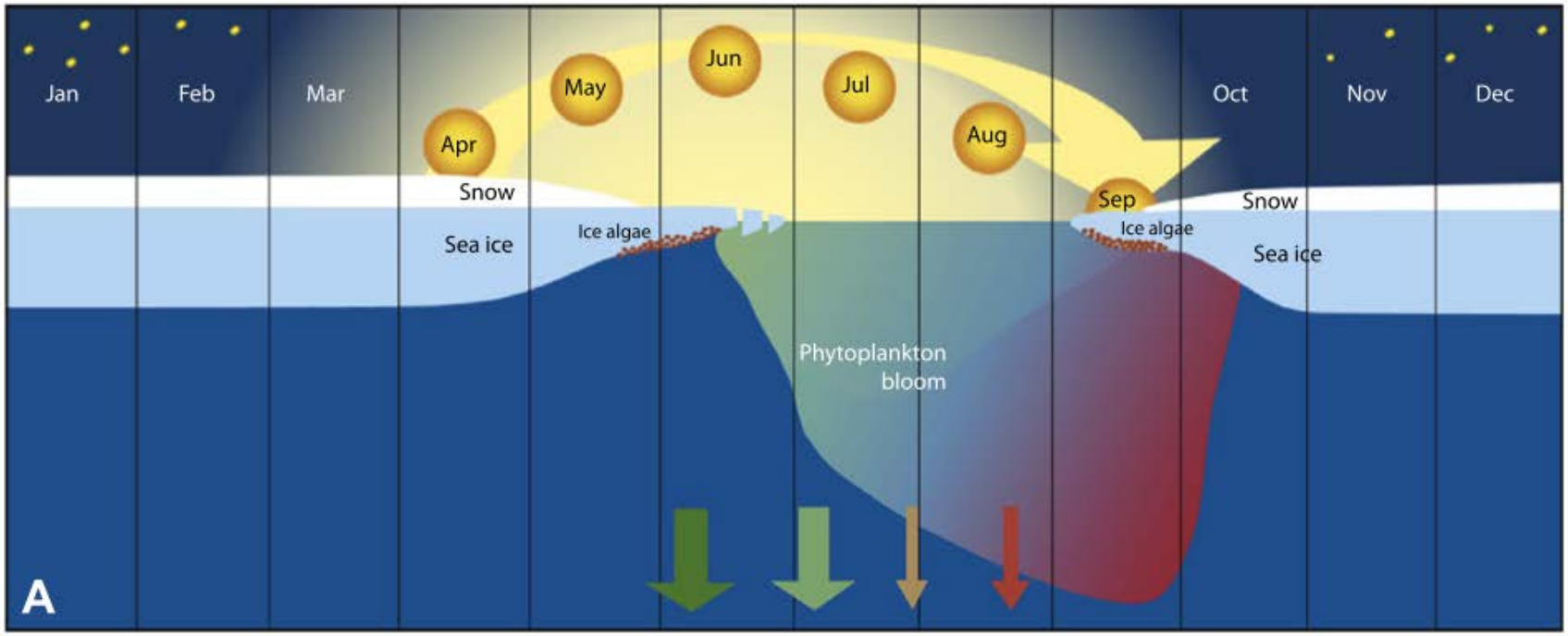


Polar Case

Growth season start → *Growth season end*

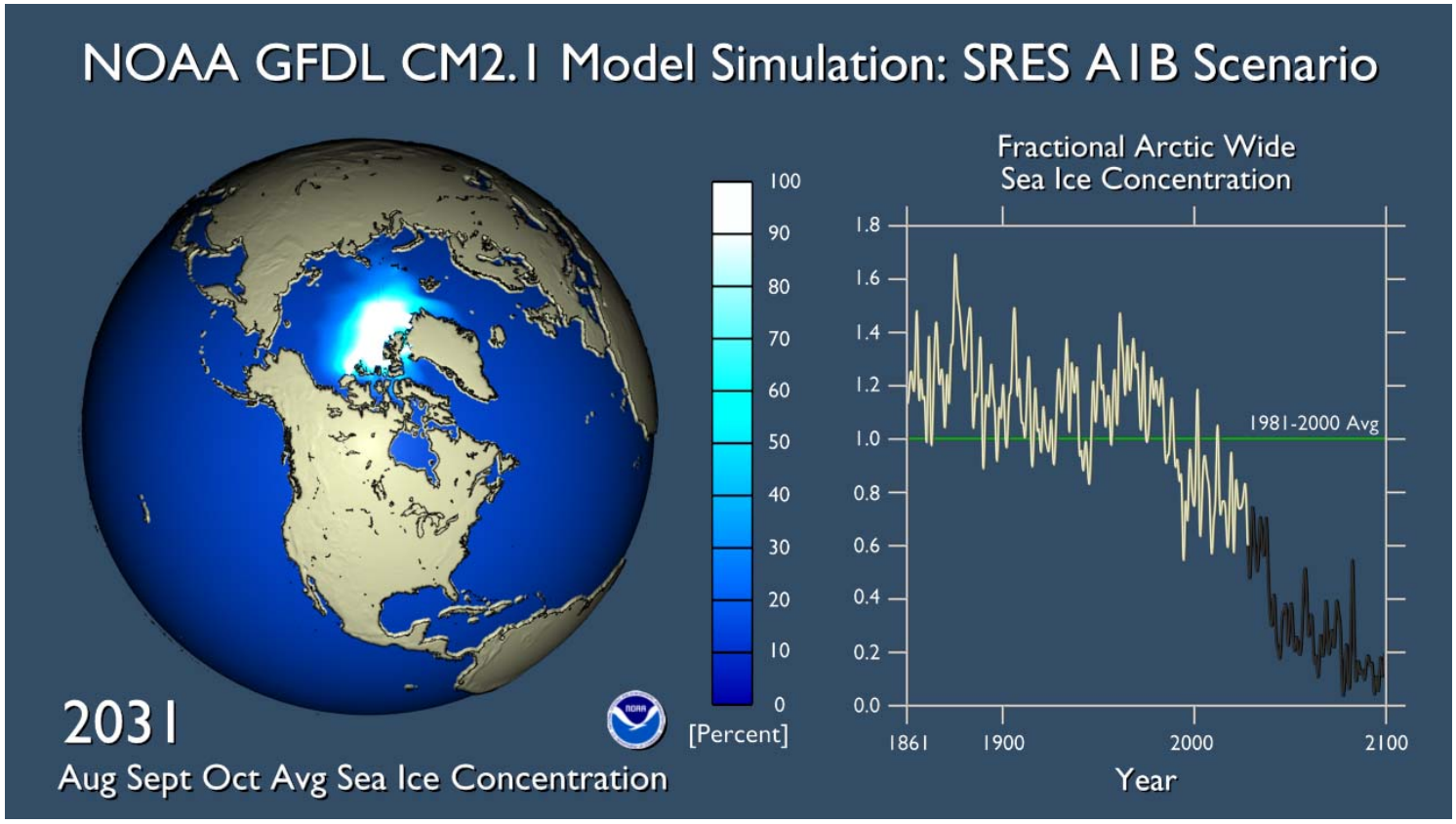
Arctic Ocean

Seasonality in seasonal ice zone (SIZ)

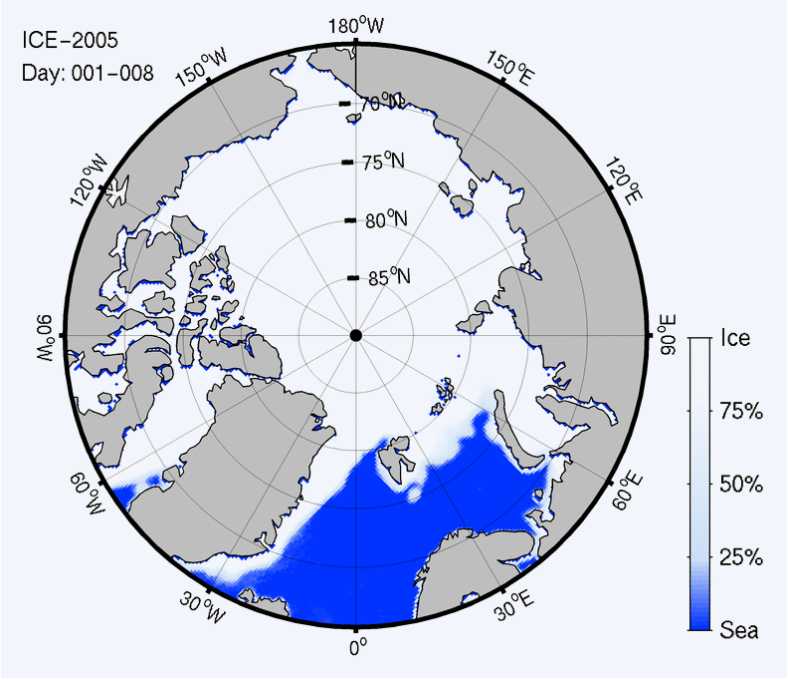


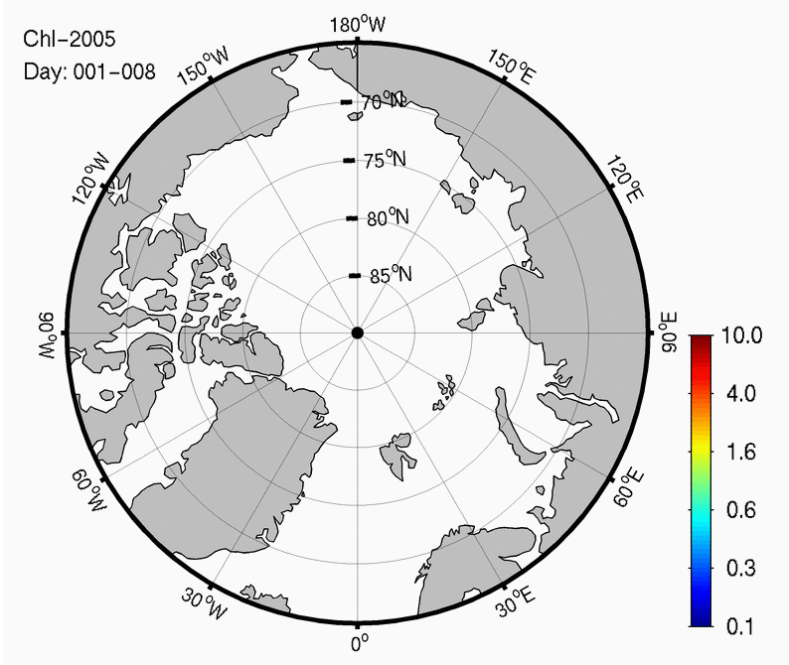
(Wassmann, 2011)

Climate change

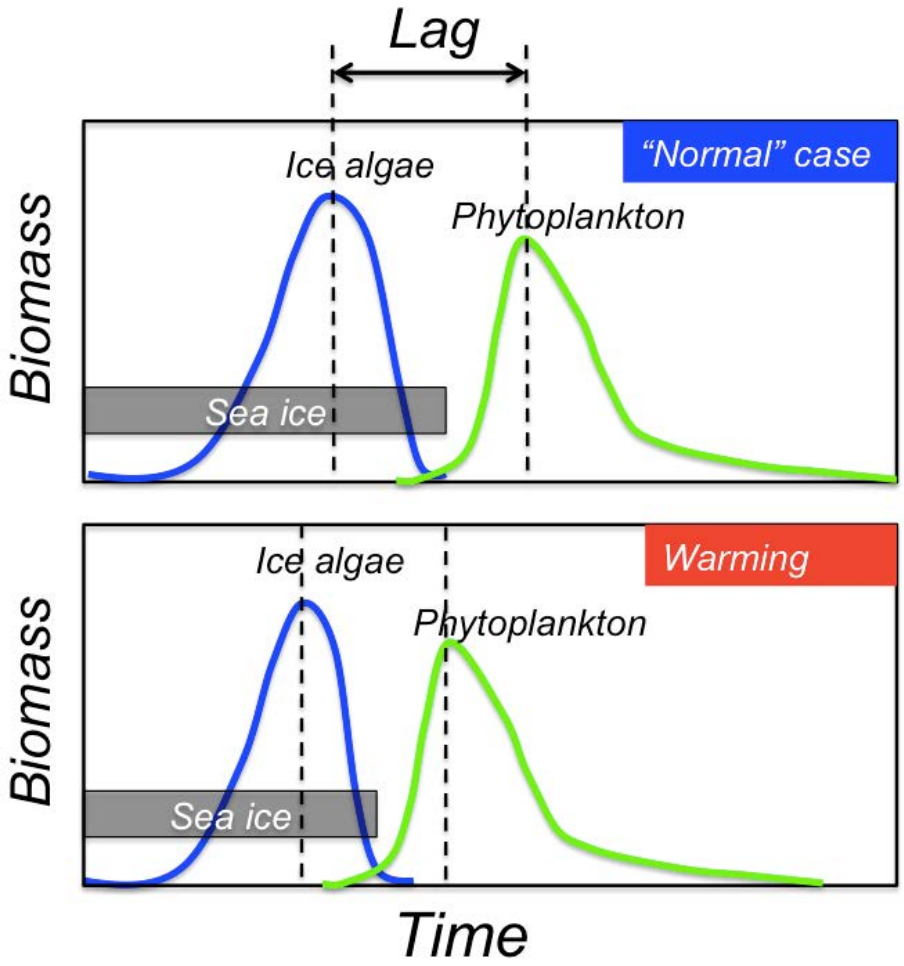


Satellite data





Conceptual view



(Ji *et al*., GCB, 2013)

On-going Work

- Yellow Sea:

  the linkage between long term variations of environmental factors and the plankton dynamics; inter-annual or decadal scale modeling about the YS ecosystem (focusing on the physical-biological interaction) would contribute to explain the detailed plankton phenology.

- Arctic Ocean:

  how of the primary production phenology affect the zooplankton (e.g. copepod biogeography)?

Thanks for your attention!

Warmly invite you to Qingdao and FIO