Ocean color and SST applications in Chinese water

Remote Sensing of "Wind Pump" Effects on Marine System

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1 Introduction

Scientific question

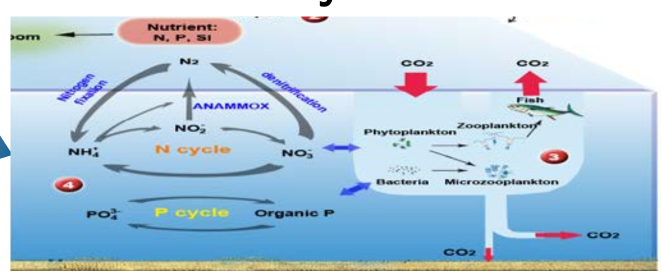
Driver?
Ocean dynamic ?
Climate change→Marine Ecosystem→Phytoplankton?

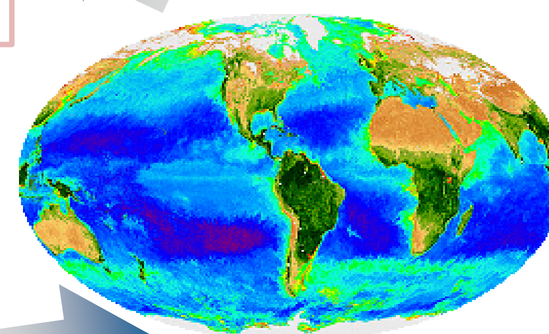
Climate Changes

Co2

wind

Marine system





Phytoplankton

“Wind Pump”?

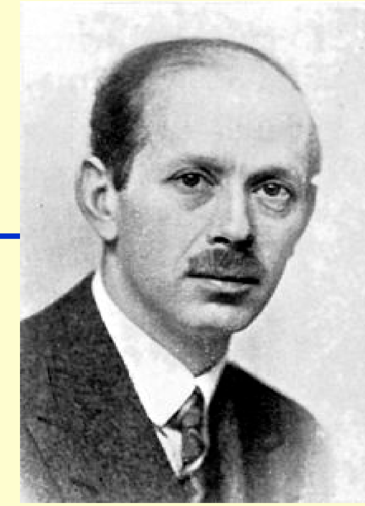
Is a series of processes driven by wind

that influence ocean currents and water movement

which subsequently affects ocean’s ecological status.

Phytoplankton Blooms

1. depth hypothesis

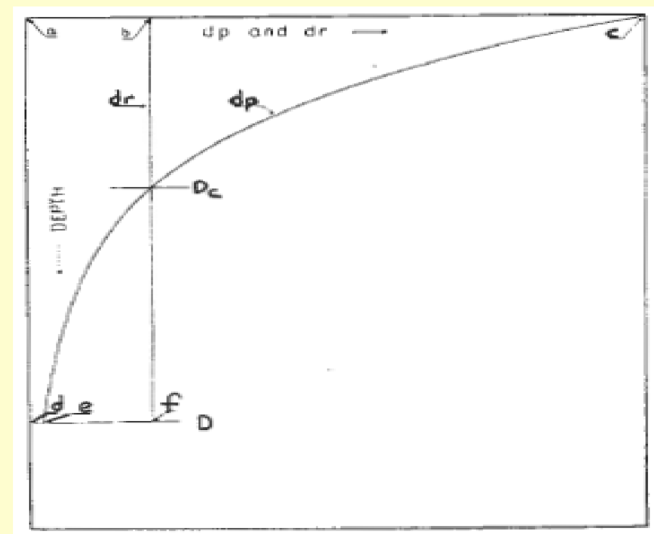


1. critical depth hypothesis

:

(Sverdrup 1953) .

Mixing depth < critical depth



Gran and Braarud 1935

在营养盐对浮游植物的生长无限制作用时

On Conditions for the Vernal Blooming of Phytoplankton.

By

H. U. Sverdrup,

Norsk Polarinstitutt, Oslo.

Bloom

- Local
- Time
- Period

2. Eutrophication hypothesis

Nutrient /light-temperature

2. "Eutrophication" (Edmondson， 1975)

human activities

ABNORMAL LEUCOCYTE COMPOSITION AND SODIUM TRANSPORT IN ESSENTIAL HYPERTENSION

R. P. S. Edmondson R. D. Thomas
P. J. Hilton J. Patrick *
N. F. Jones

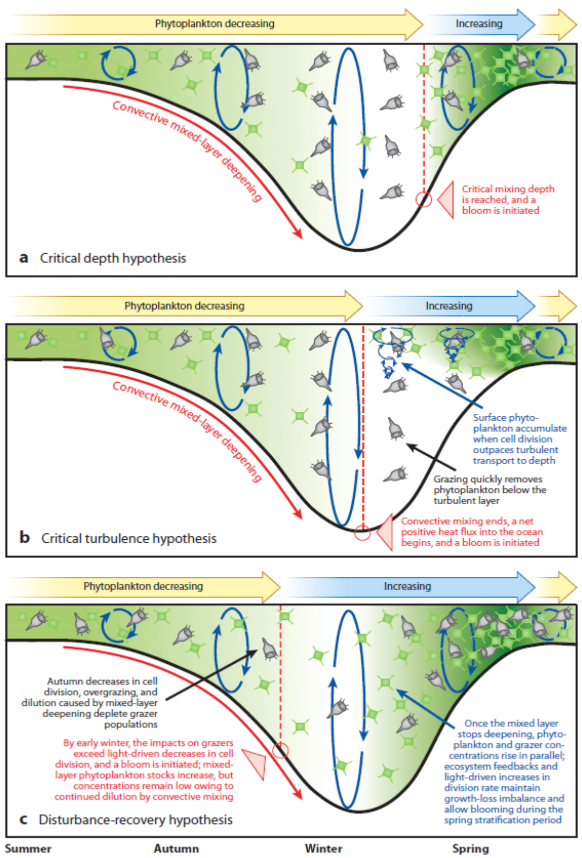
Renal Laboratory, St. Thomas' Hospital, London SE1

Bloom

- Local
- Time
- Period

半个多世纪以来，这些理论得到细化、深化、和发展

critical depth hypothesis



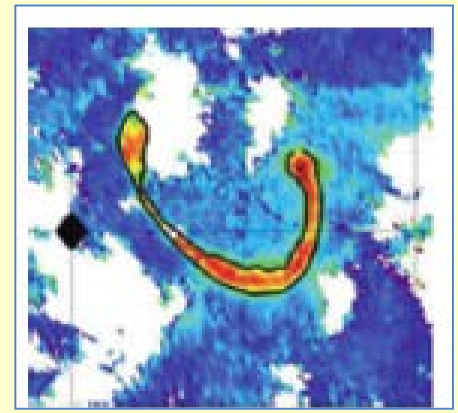
临界深度假说
critical depth hypothesis

临界湍流假说
the critical turbulence H

干扰-恢复假说
disturbance-recovery H

Eutrophication

N
P
N：P
Fe



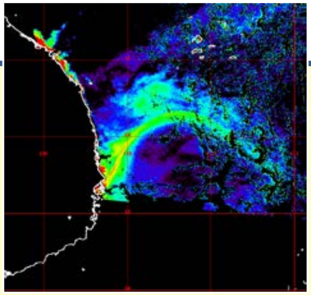
Resurrecting the Ecological Underpinnings of Ocean Plankton Blooms

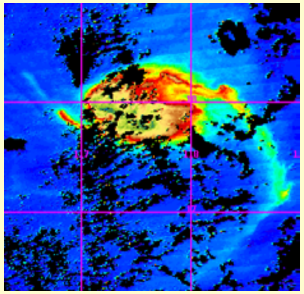
Michael J. Behrenfeld[1] and Emmanuel S. Boss[2]

但是仍然不能解释很多海洋藻华现象

?

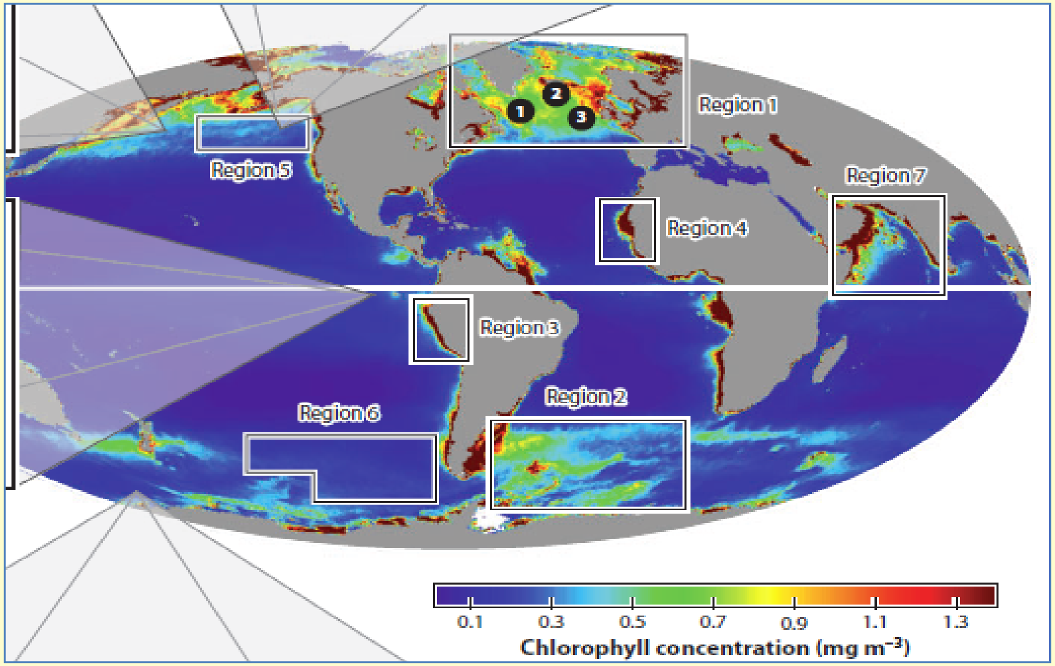
- No local
- Time and location changed
- Short period

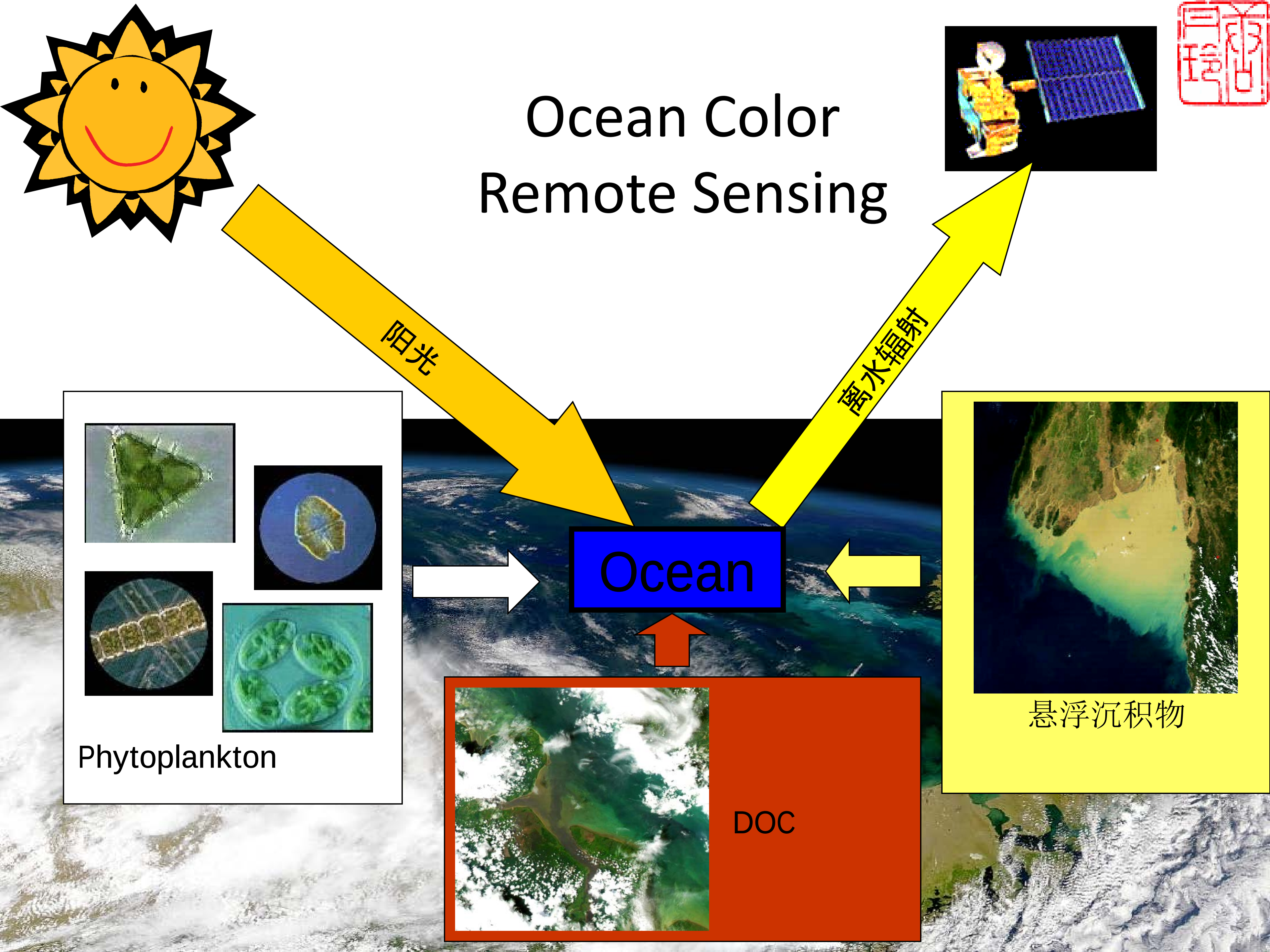




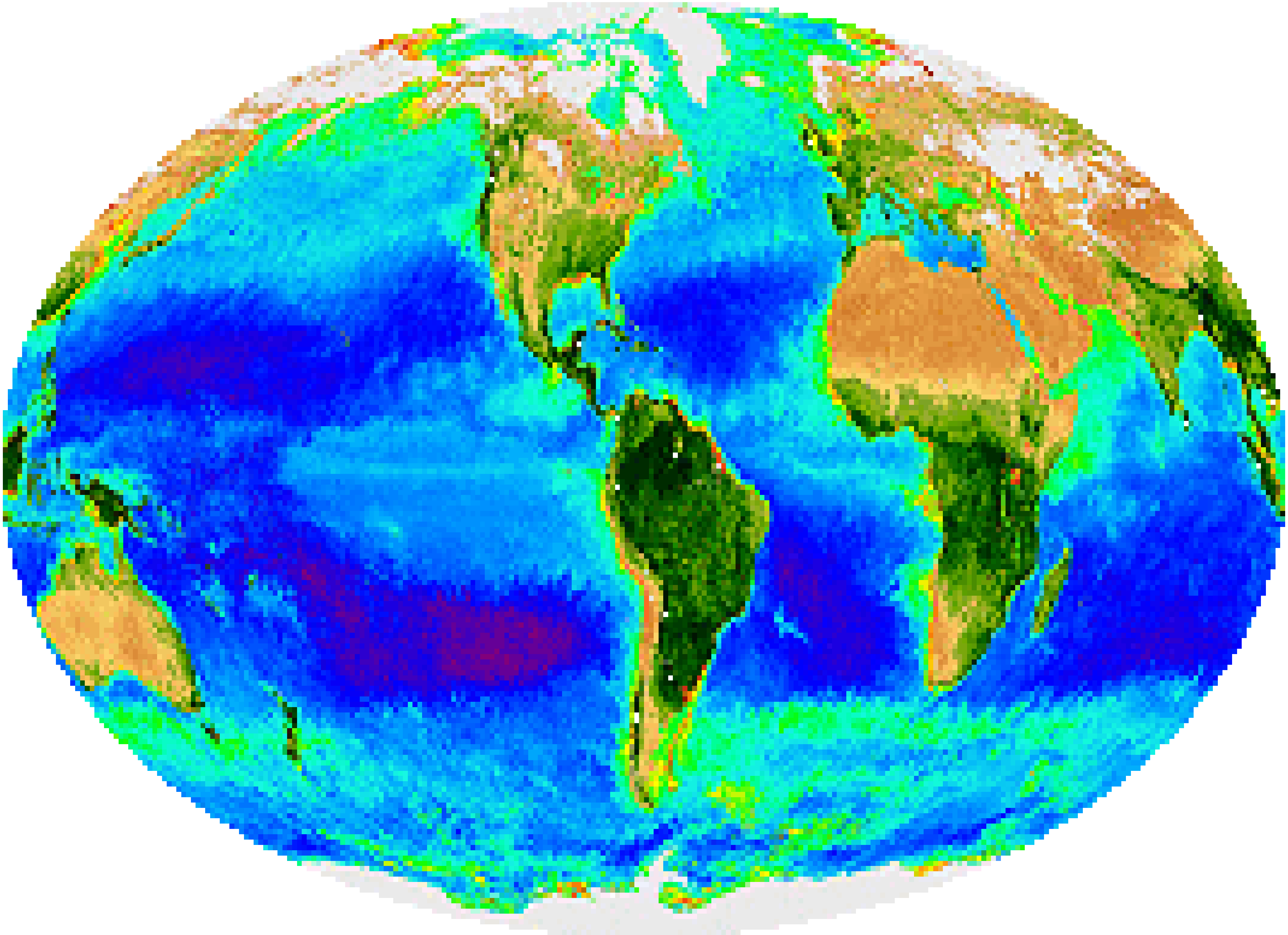
- Ocean phytoplankton bloom observed from satellite：
  - Mixing depth 〉 critical depth
  - No Eutrophication
  - (no N)
  - Time and location

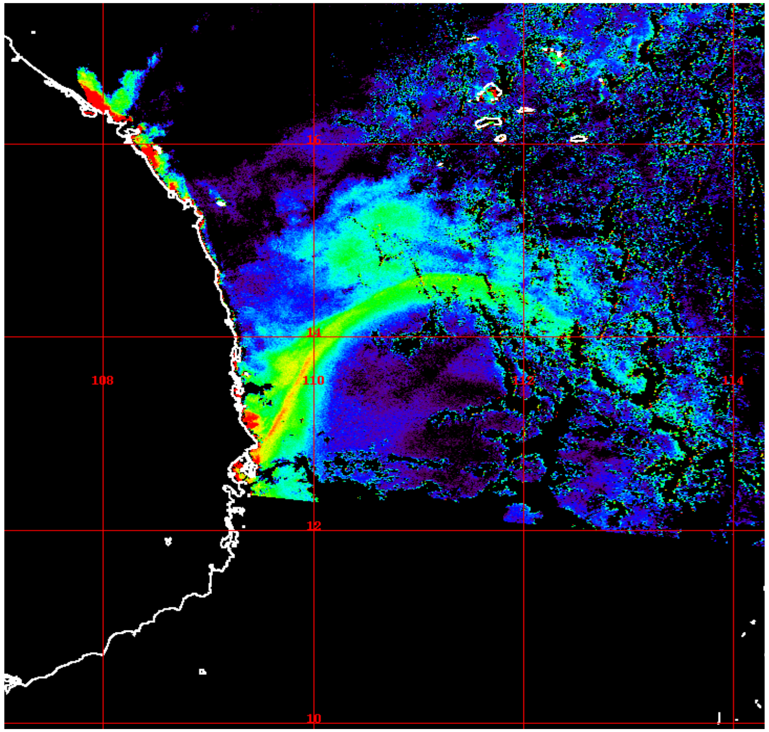
SeaWiFS
Chlor

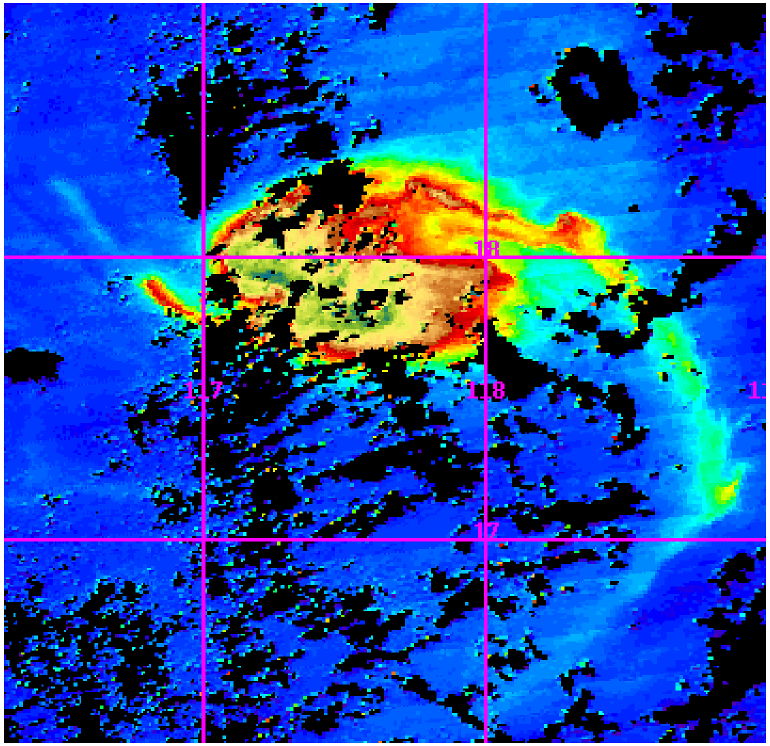



Ocean Color
Remote Sensing
阳光
离水辐射
Ocean
Phytoplankton
DOC
悬浮沉积物

Marine Primary Production




16
14
108
110
114
12
10


18
117
118
17

Explain Phytoplankton bloom

- Local bloom
- time period (season)
- Long duration

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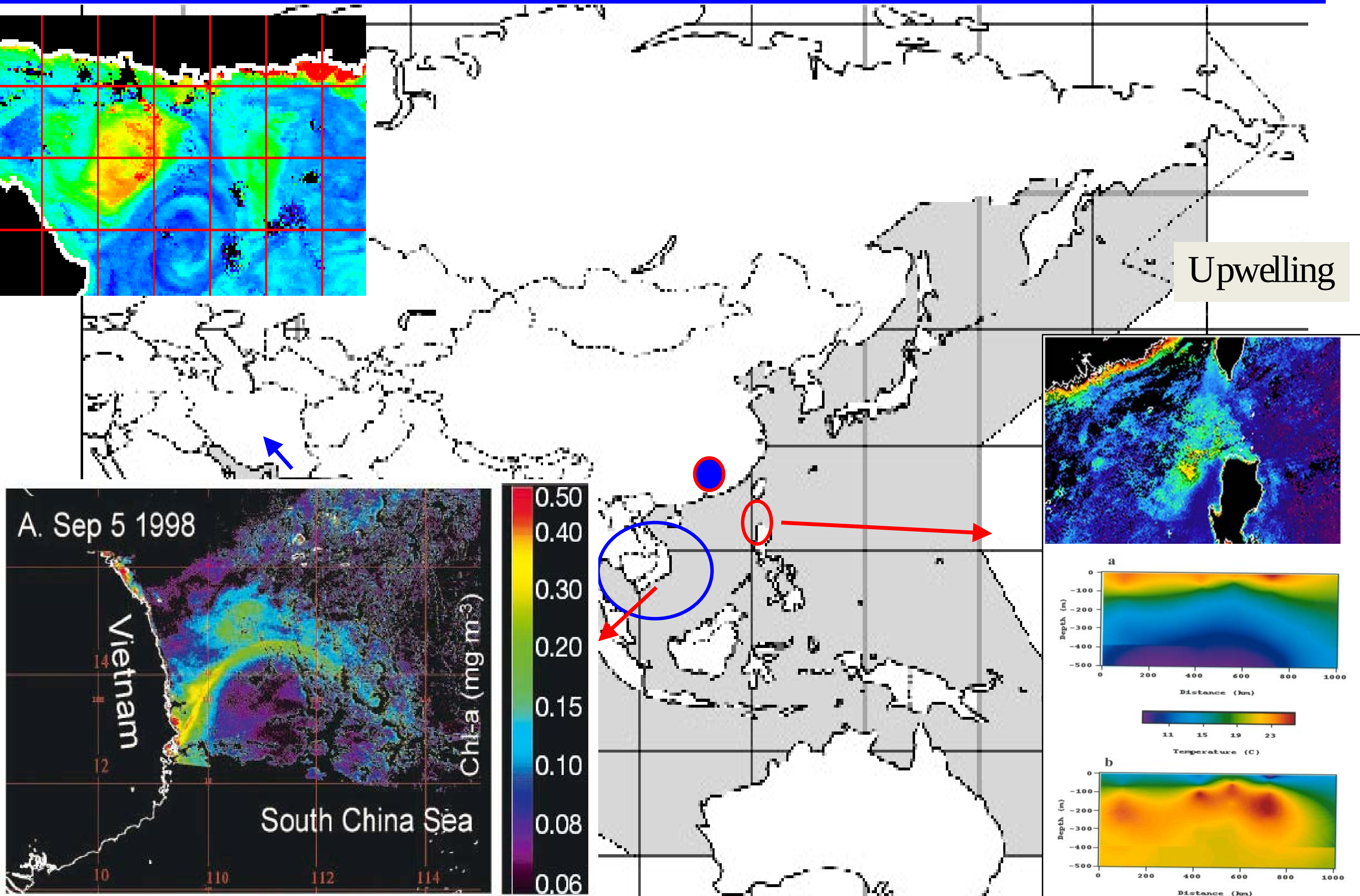
2

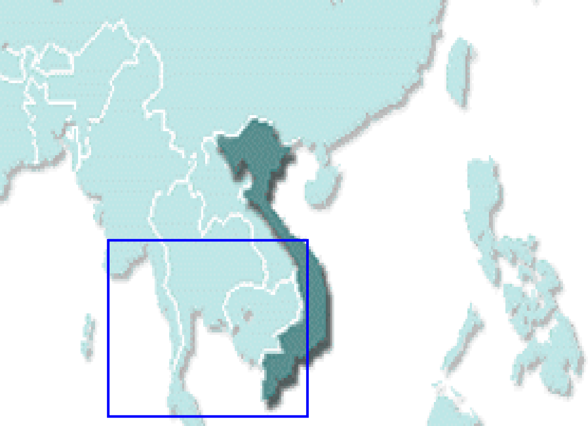
Phytoplankton Bloom –wind pump induced

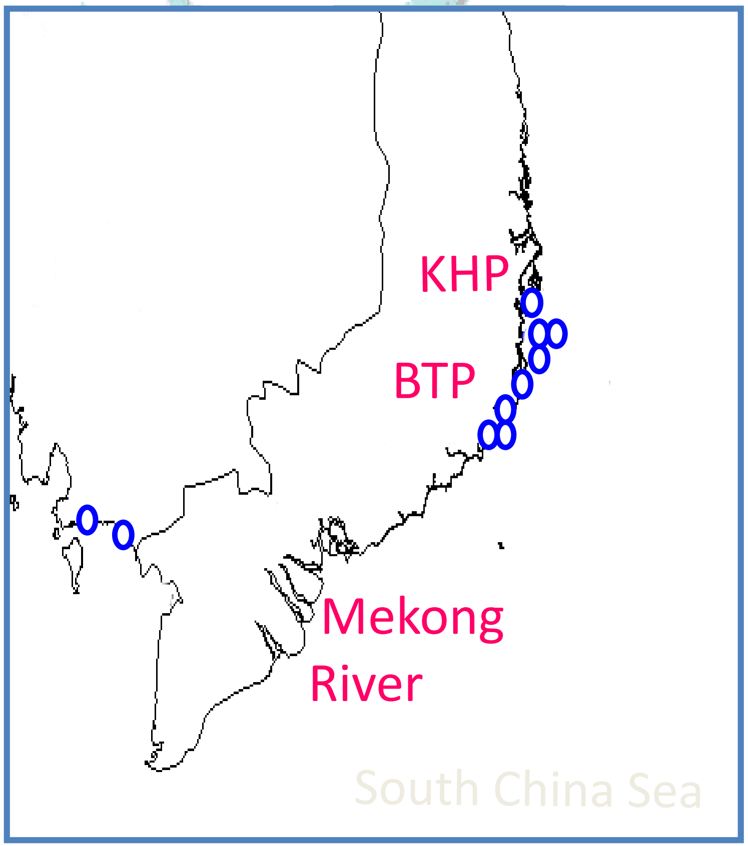
Cold eddy –upwelling-phytoplankton bloom / DanLing TAN

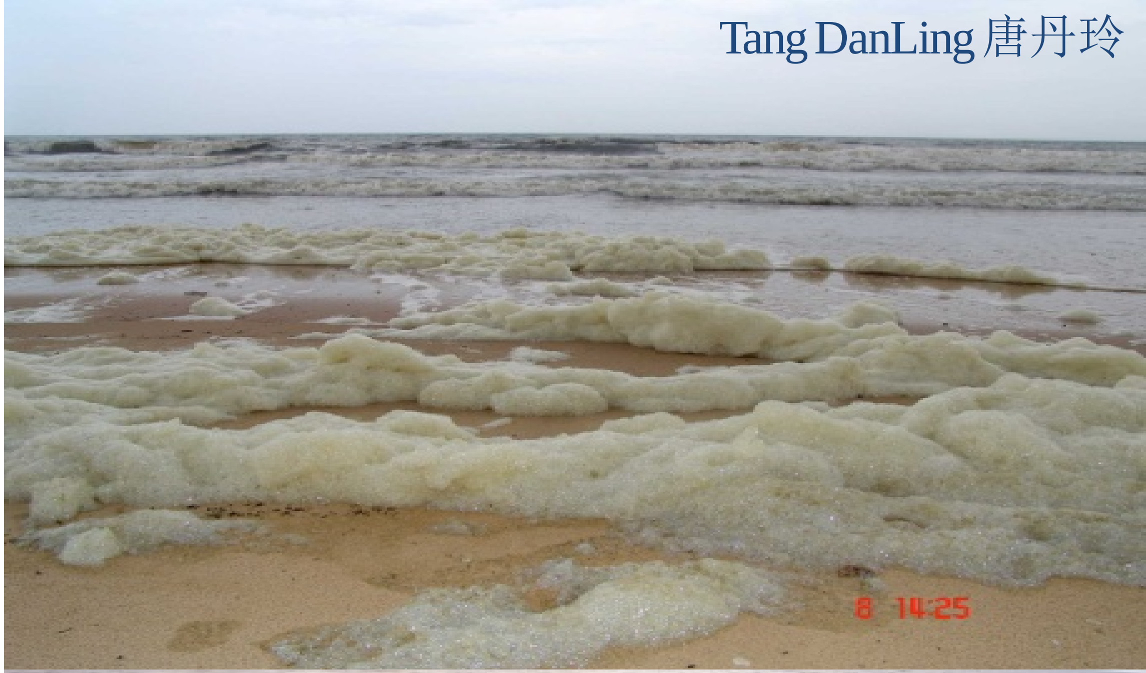


Tang et al., JGR, MEPS, JGR, JGR

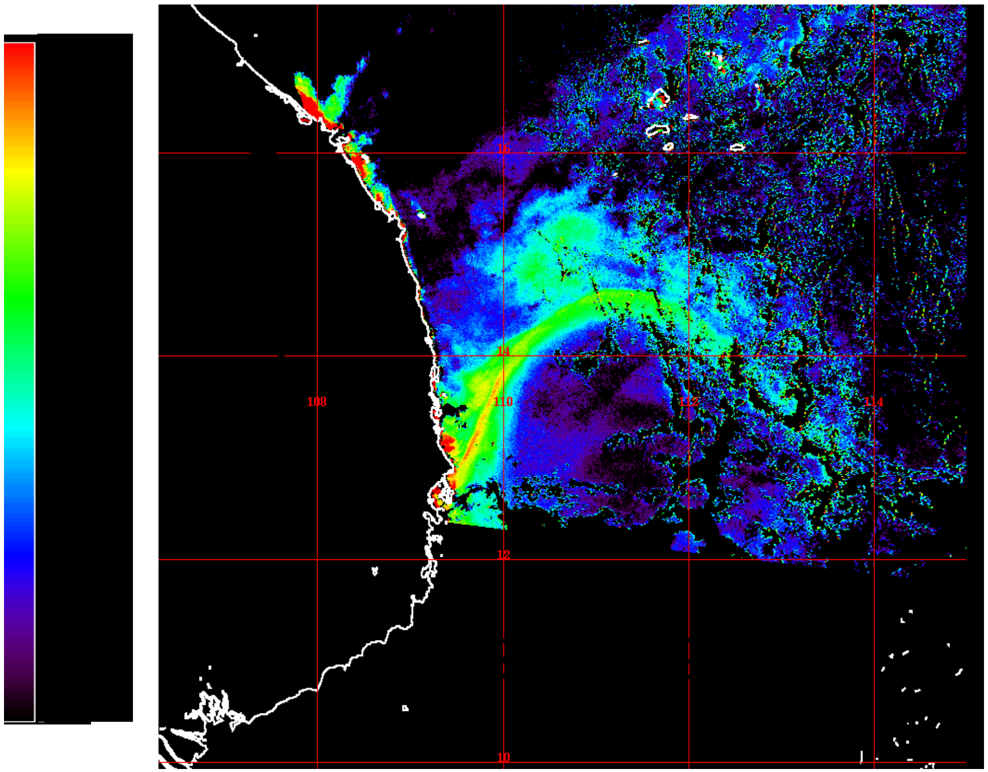
Tang et al., MEPS

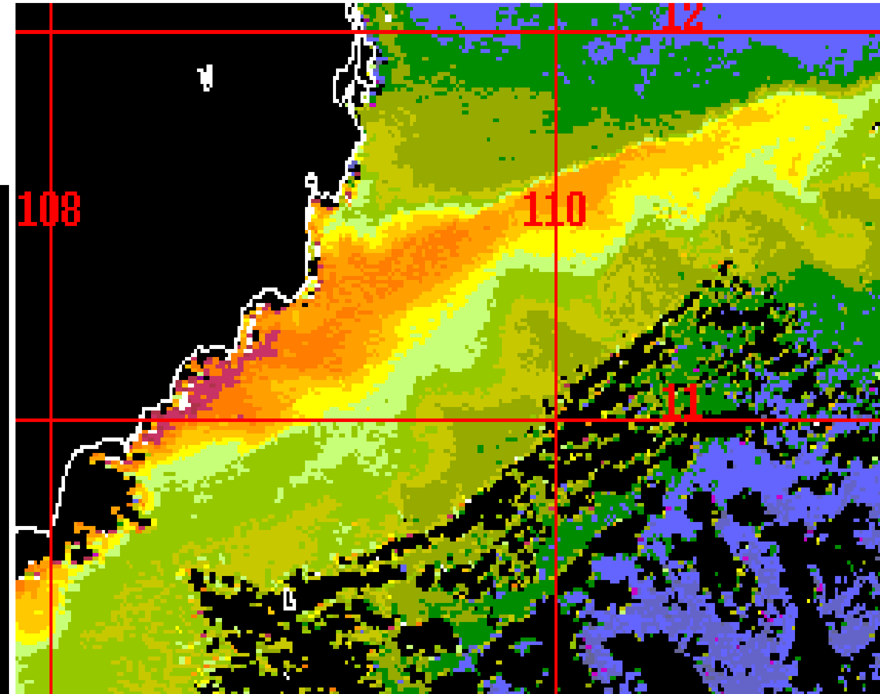






Tang DL et al., 2004, GJR

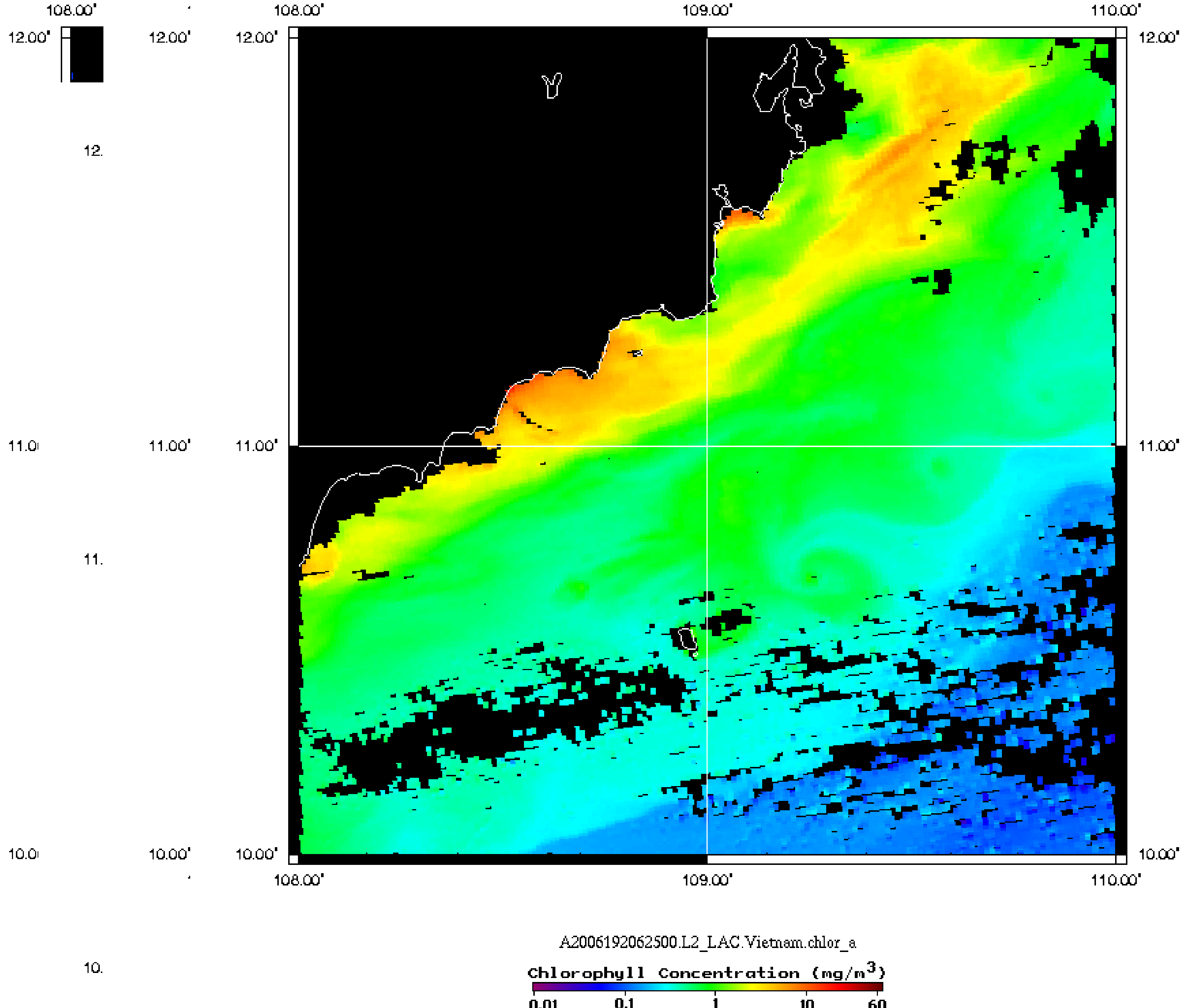




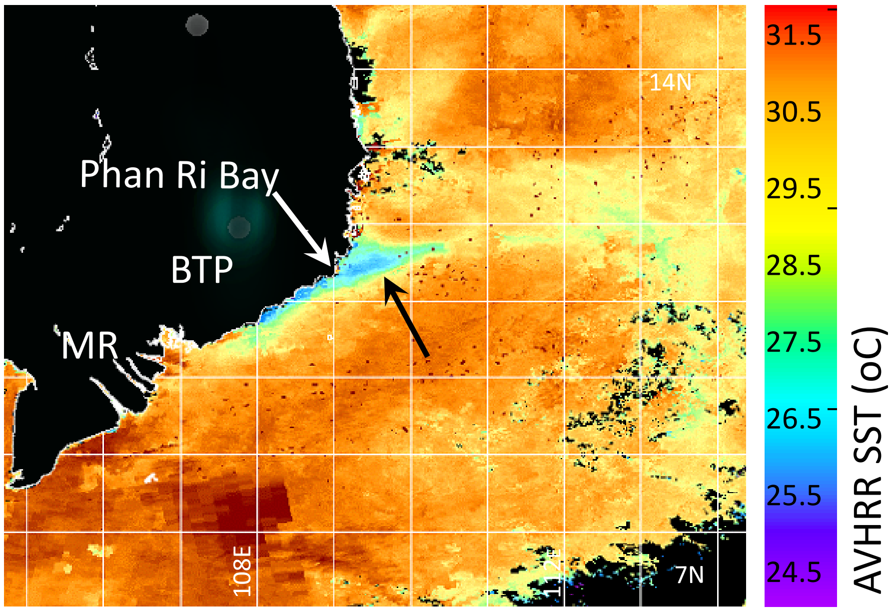
?

Offshore water?

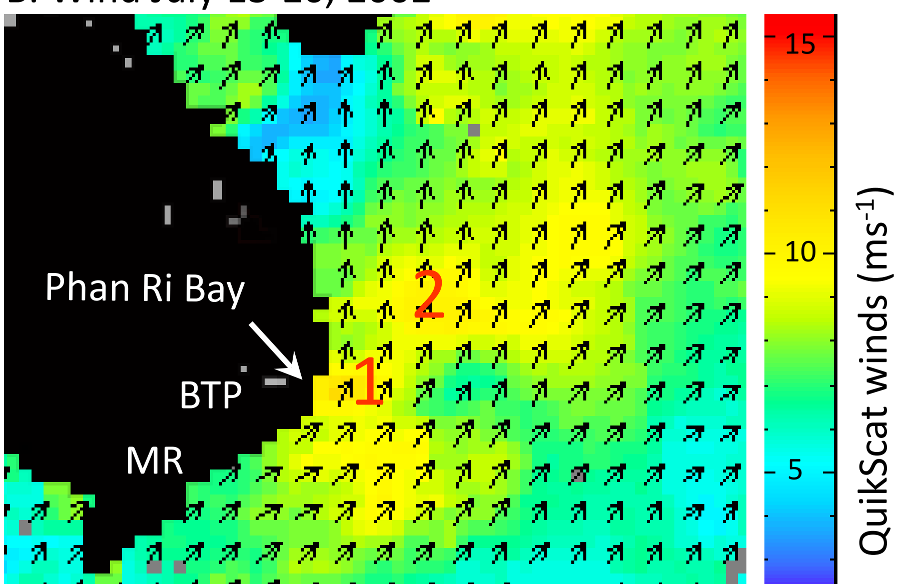
(Tang et al. 2004, JGR)

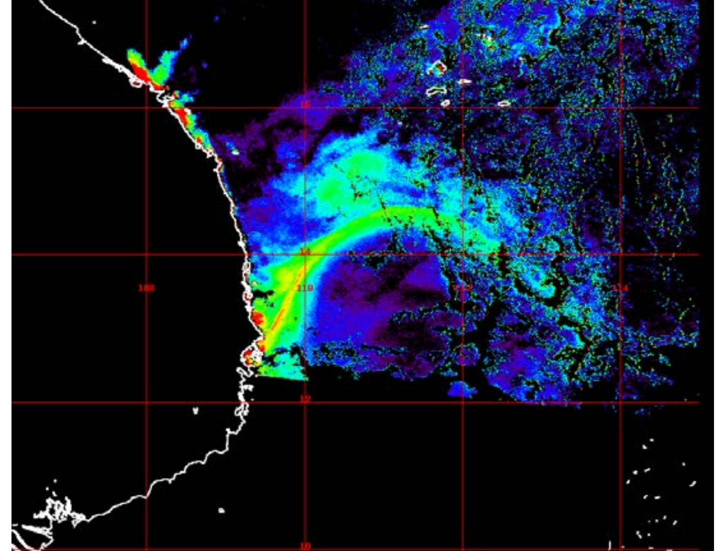

108.00'
109.00'
110.00'
12.00'
11.00'
10.00'
A2006192062500.L2_LAC.Vietnam.chlor_a
Chlorophyll Concentration (mg/m³)
0.01
0.1
1
10
60

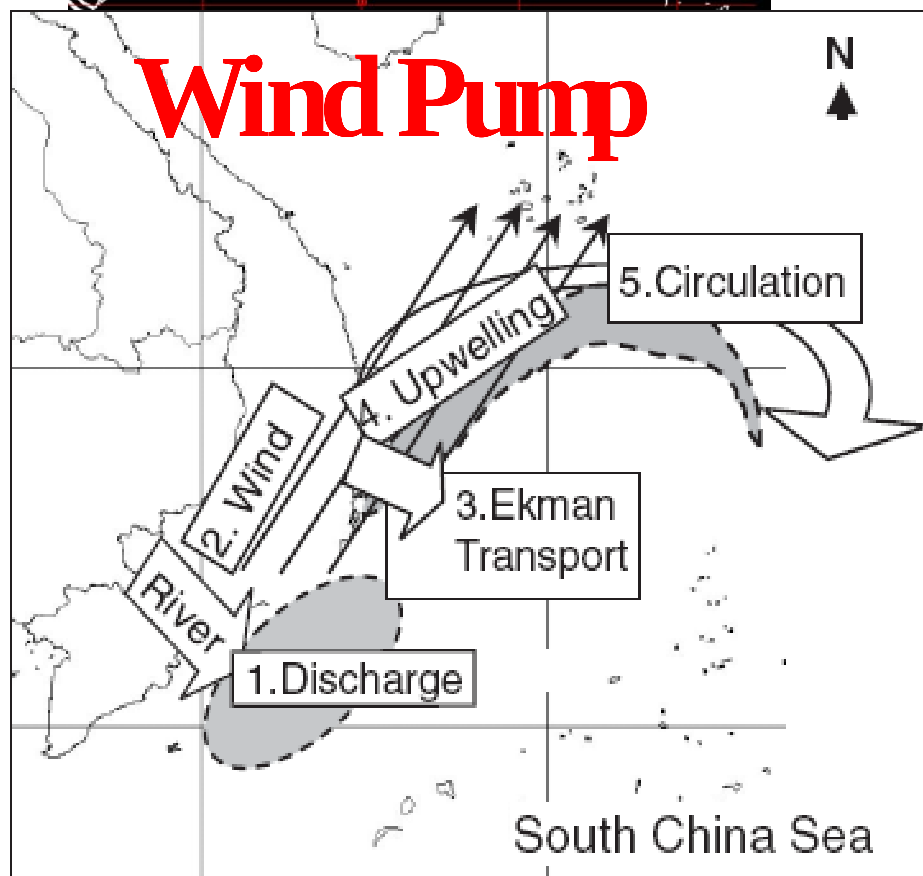
A. SST July 23, 2002



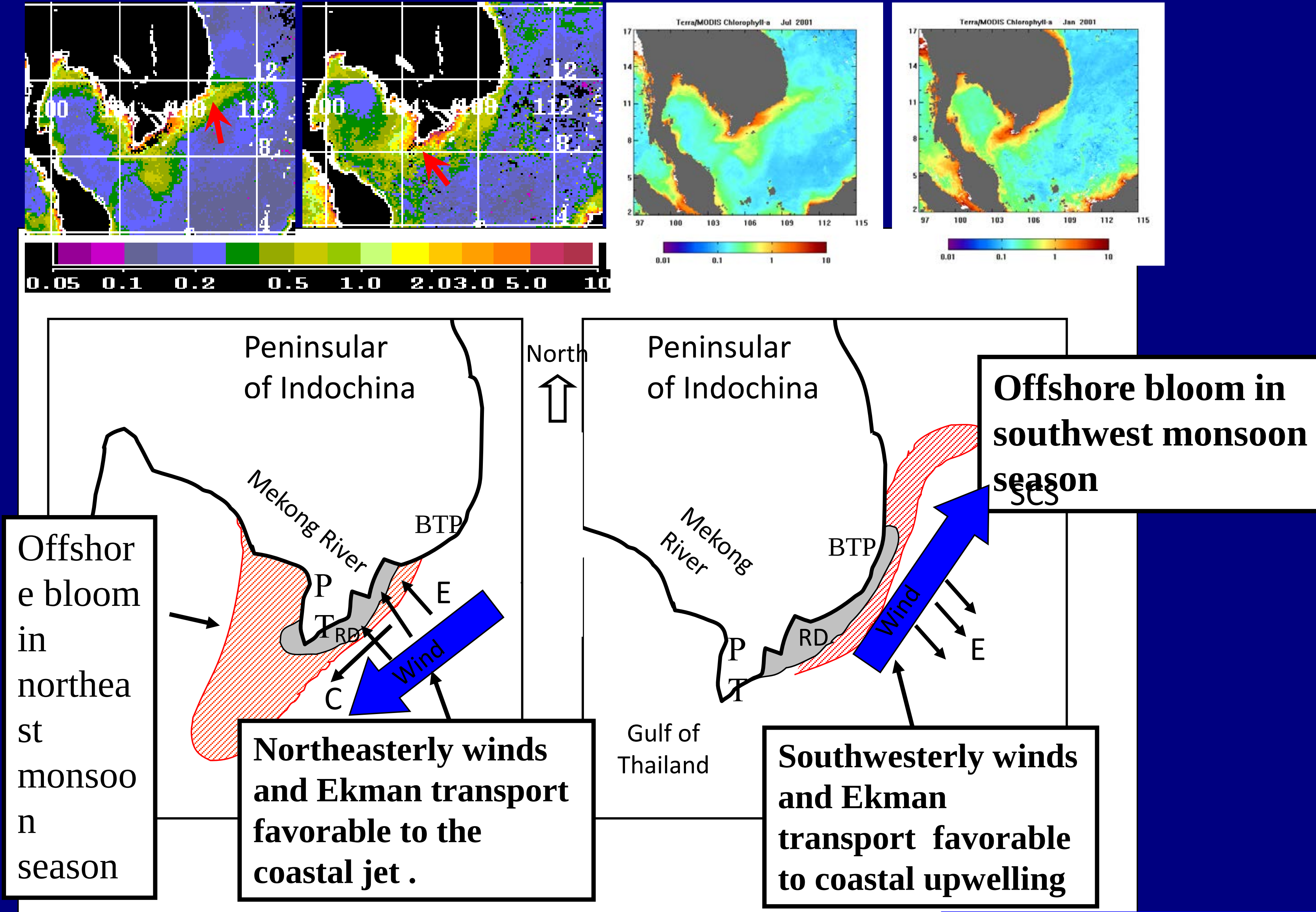
B. Wind July 13-20, 2002



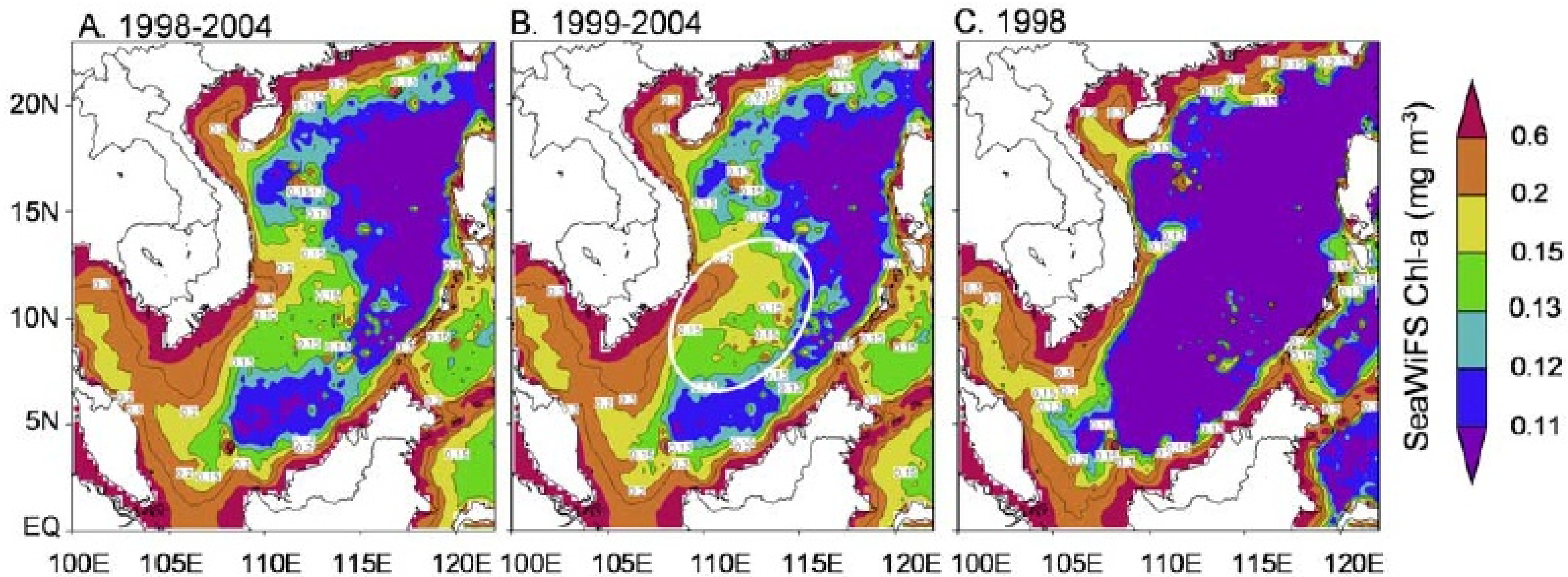


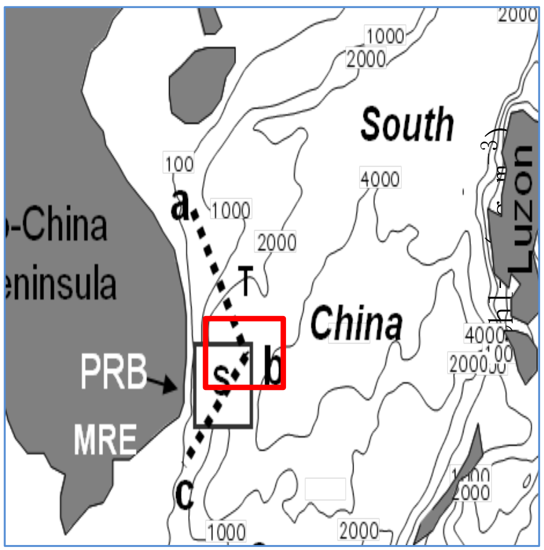


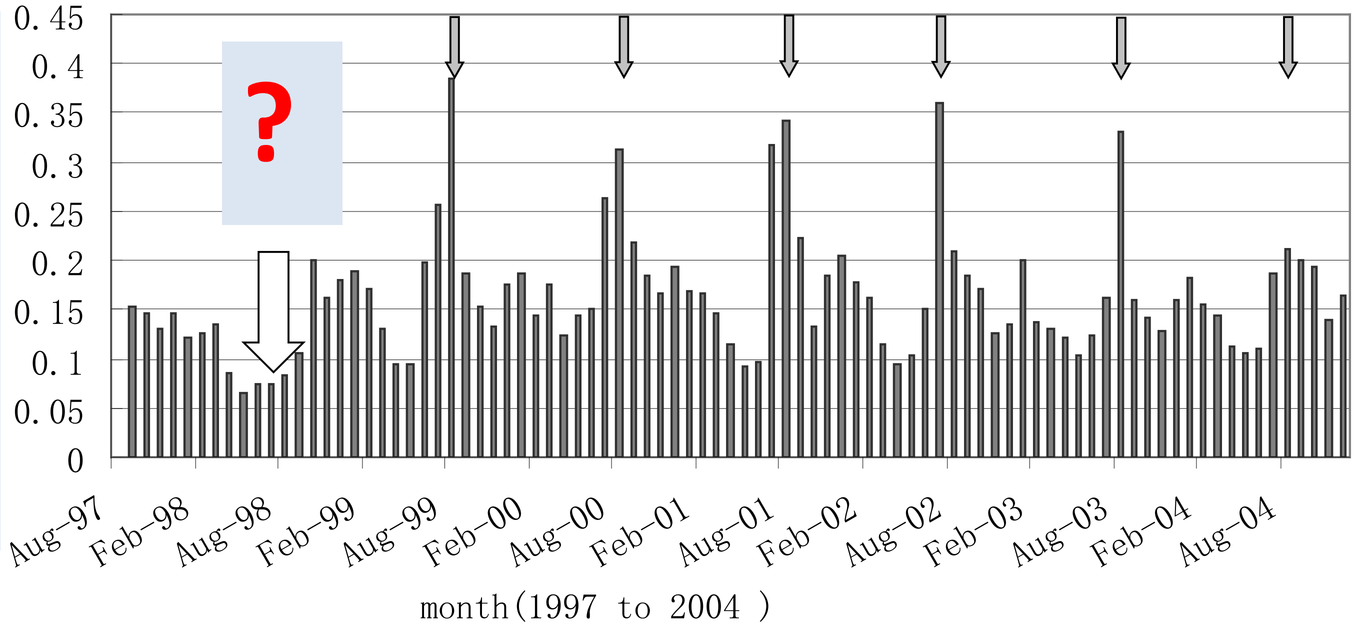
Tang et al., 2004. JGR

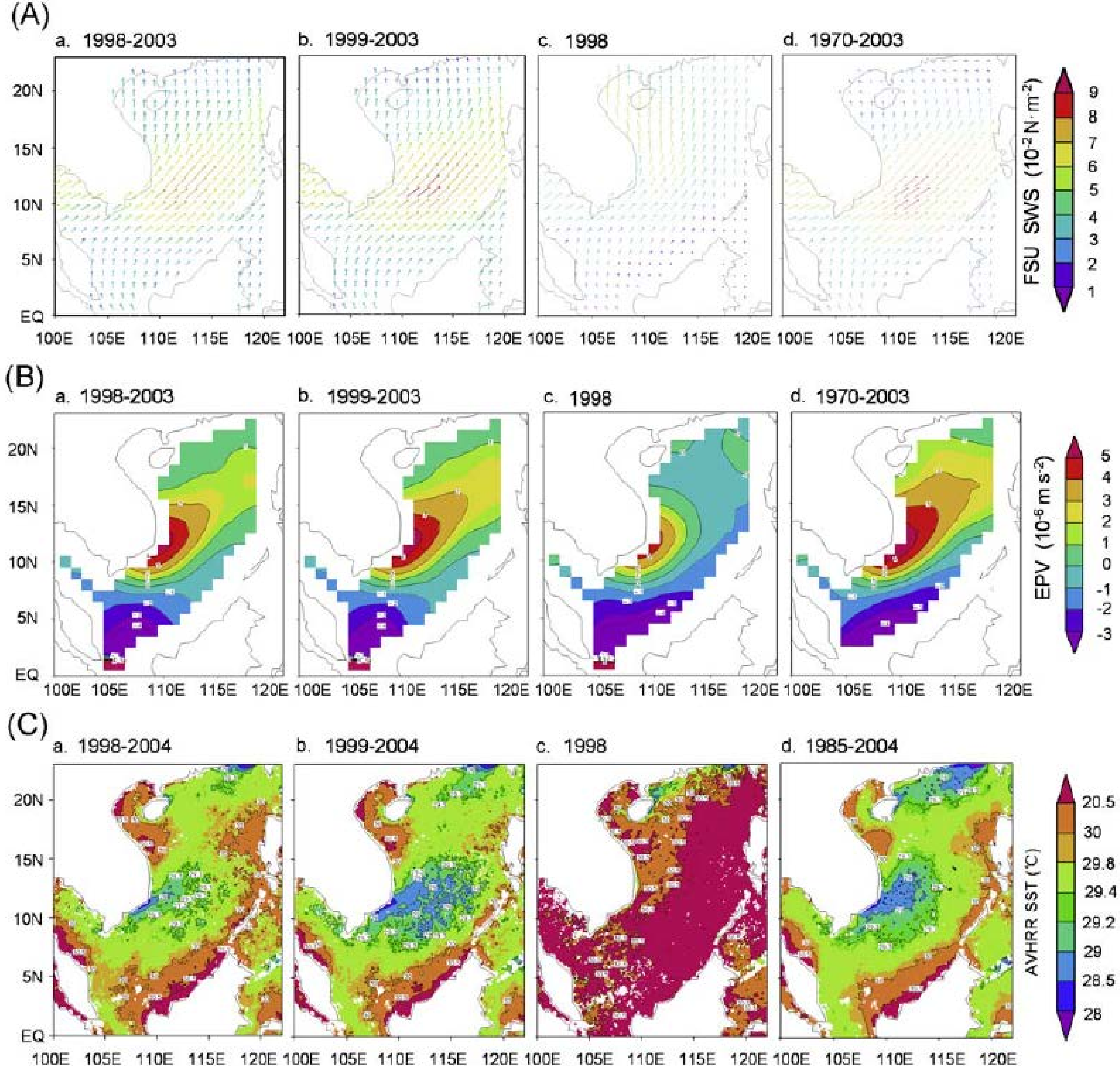


Tang et al., 2006, JGR

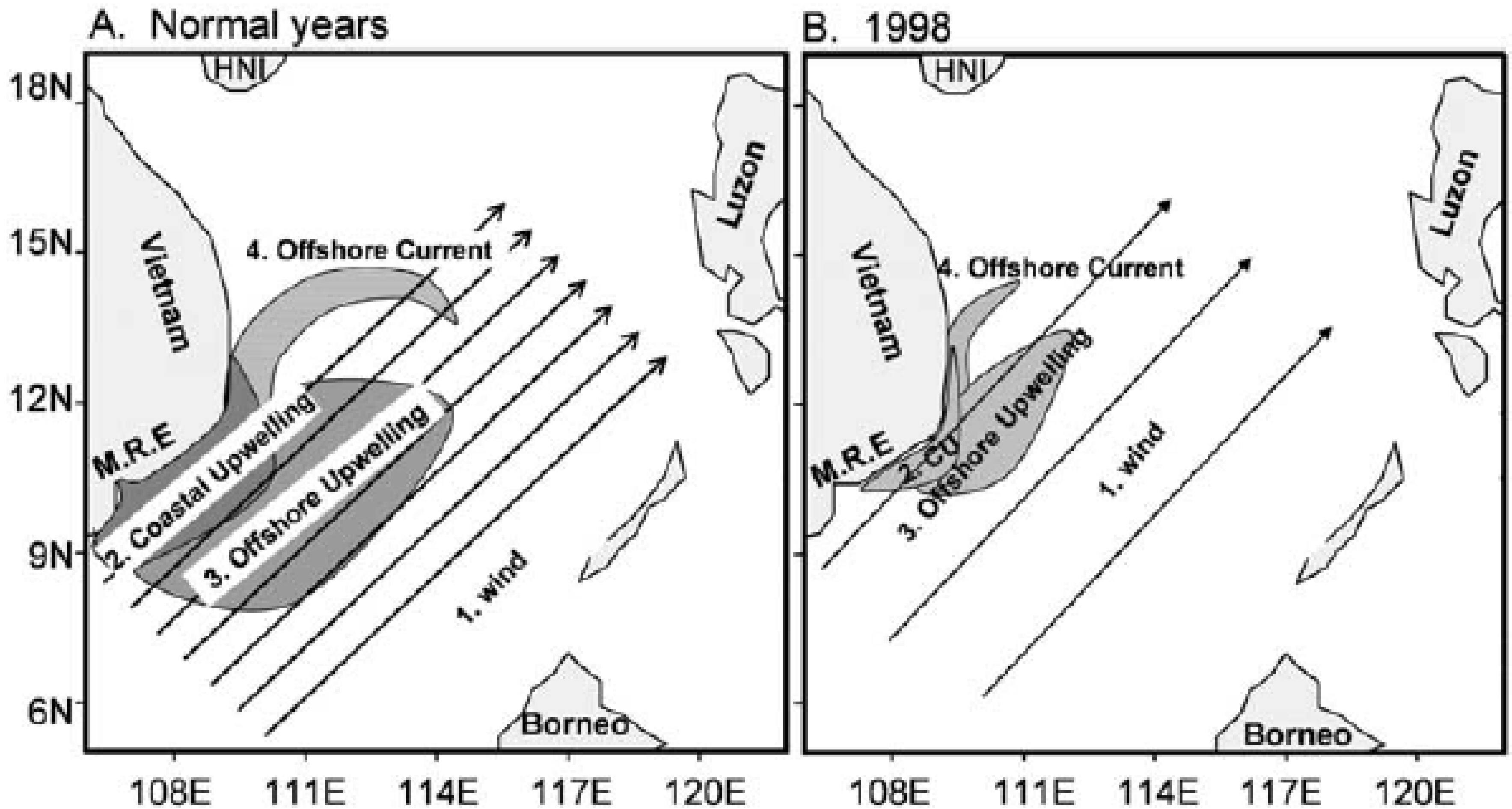

A. 1998-2004
B. 1999-2004
C. 1998
20N
15N
10N
5N
EQ
100E
105E
110E
115E
120E
SeaWiFS Chl-a (mg m^{-3})
0.6
0.2
0.15
0.13
0.12
0.11


South
China
Luzon
-China
eninsula
PRB
MRE
a
b
c
T
S
100
1000
2000
4000


?
0. 45
0. 4
0. 35
0. 3
0. 25
0. 2
0. 15
0. 1
0. 05
0
Aug-97
Feb-98
Aug-98
Feb-99
Aug-99
Feb-00
Aug-00
Feb-01
Aug-01
Feb-02
Aug-02
Feb-03
Aug-03
Feb-04
Aug-04
month(1997 to 2004)


(A)
a. 1998-2003
b. 1999-2003
c. 1998
d. 1970-2003
FSU SWS (10^{-2} N·m^{-2})
9
8
7
6
5
4
3
2
1
(B)
a. 1998-2003
b. 1999-2003
c. 1998
d. 1970-2003
EPV (10^{-6} m s^{-2})
5
4
3
2
1
0
-1
-2
-3
(C)
a. 1998-2004
b. 1999-2004
c. 1998
d. 1985-2004
AVHRR SST (°C)
20.5
30
29.8
29.4
29.2
29
28.5
28
20N
15N
10N
5N
EQ
100E
105E
110E
115E
120E

Wind pump


A. Normal years
B. 1998
HNI
Vietnam
Luzon
Borneo
M.R.E
4. Offshore Current
2. Coastal Upwelling
3. Offshore Upwelling
1. wind
2. CU
18N
15N
12N
9N
6N
108E
111E
114E
117E
120E

Wind is very important!

How about Typhoon?

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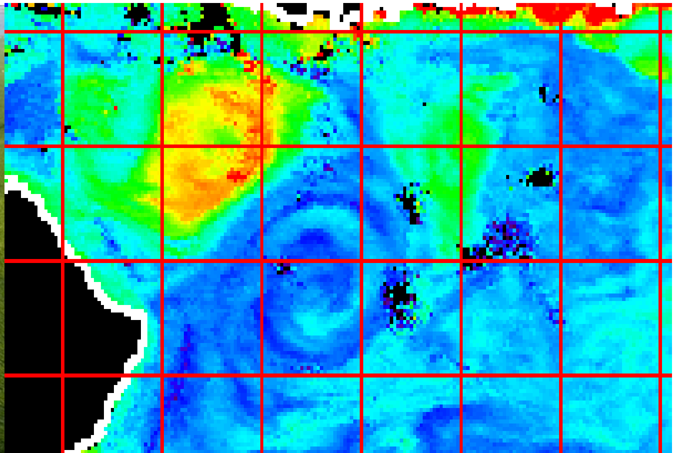
3

Typhoon impact on Marine Ecosystem

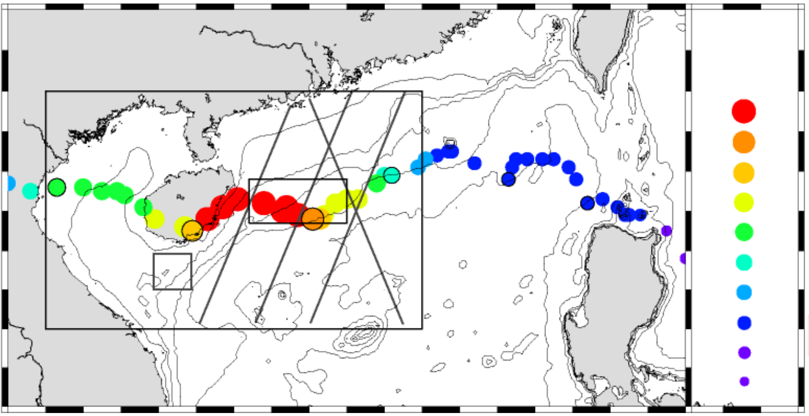
Climate Change → SST –> Typhoon

?

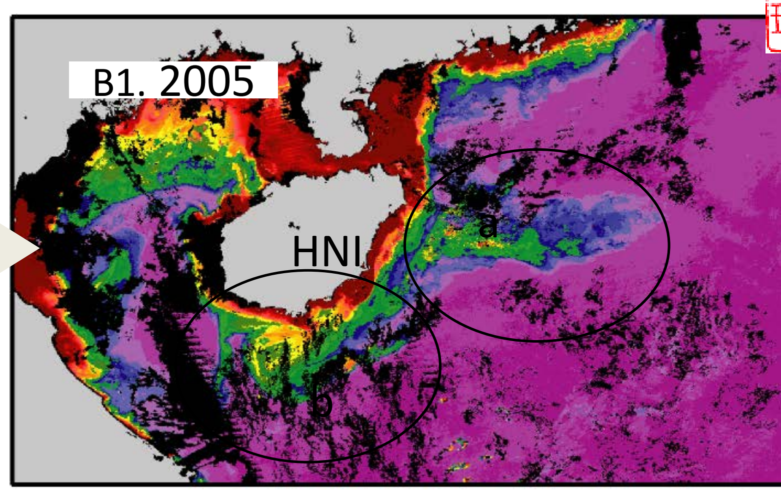
Marine ecosystem phytoplankton



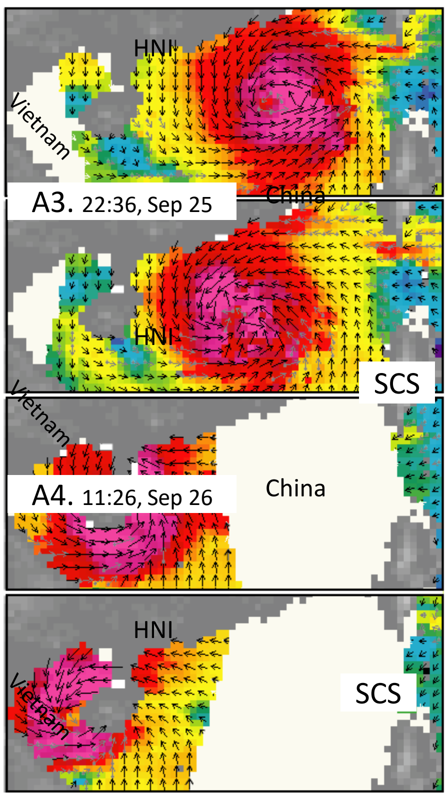
DanLing TANG



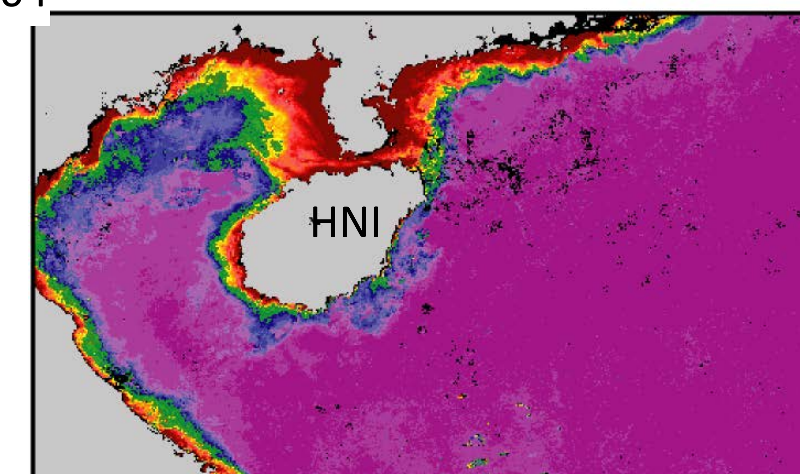
B. Post-typhoon Chl-a



Damrey, Sep 2005

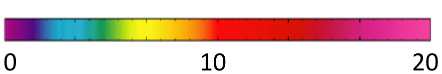


B2. 2002-2004



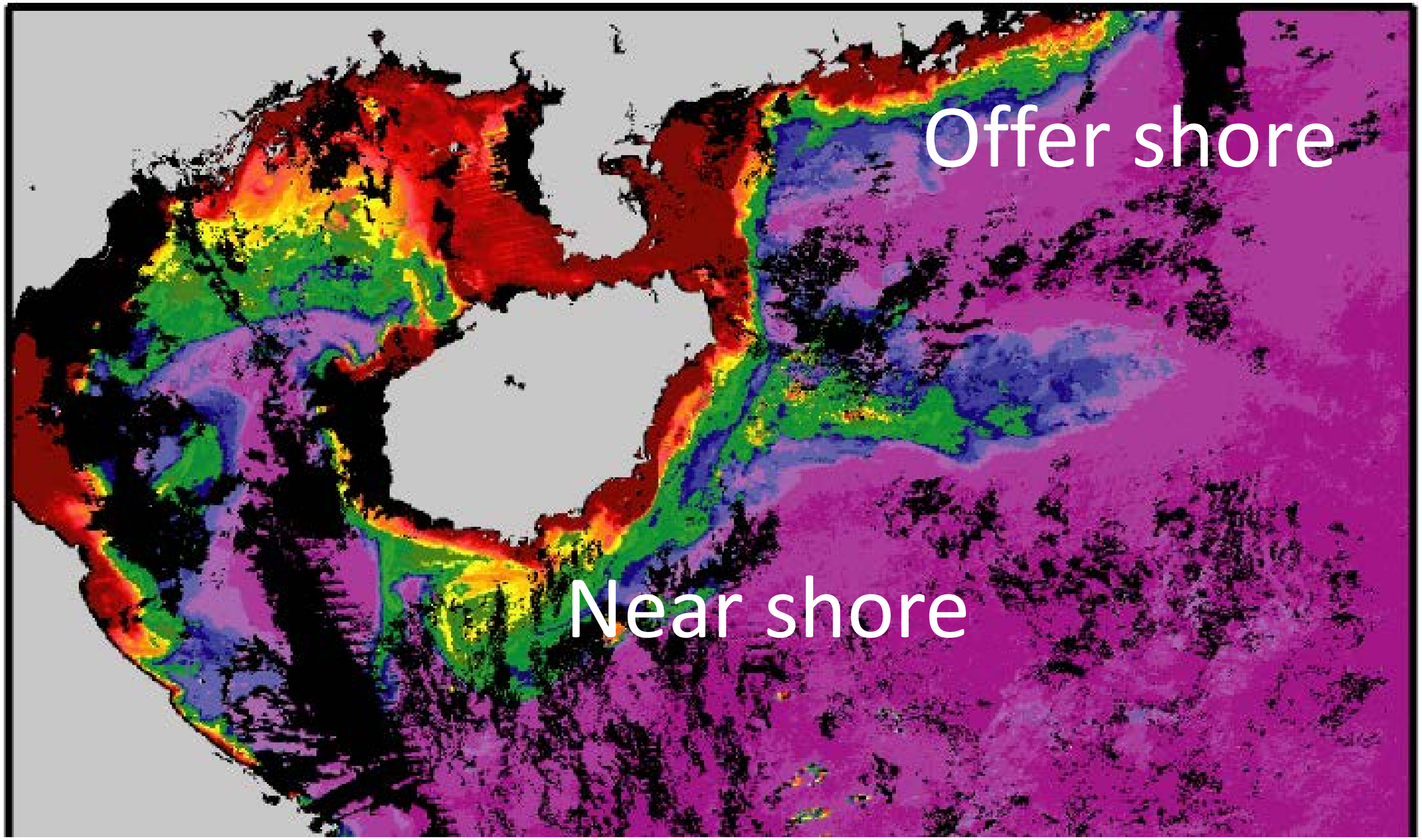
Modis Chl-a (mg m^{-3})

QuikScat Wind Vectors (m/s)

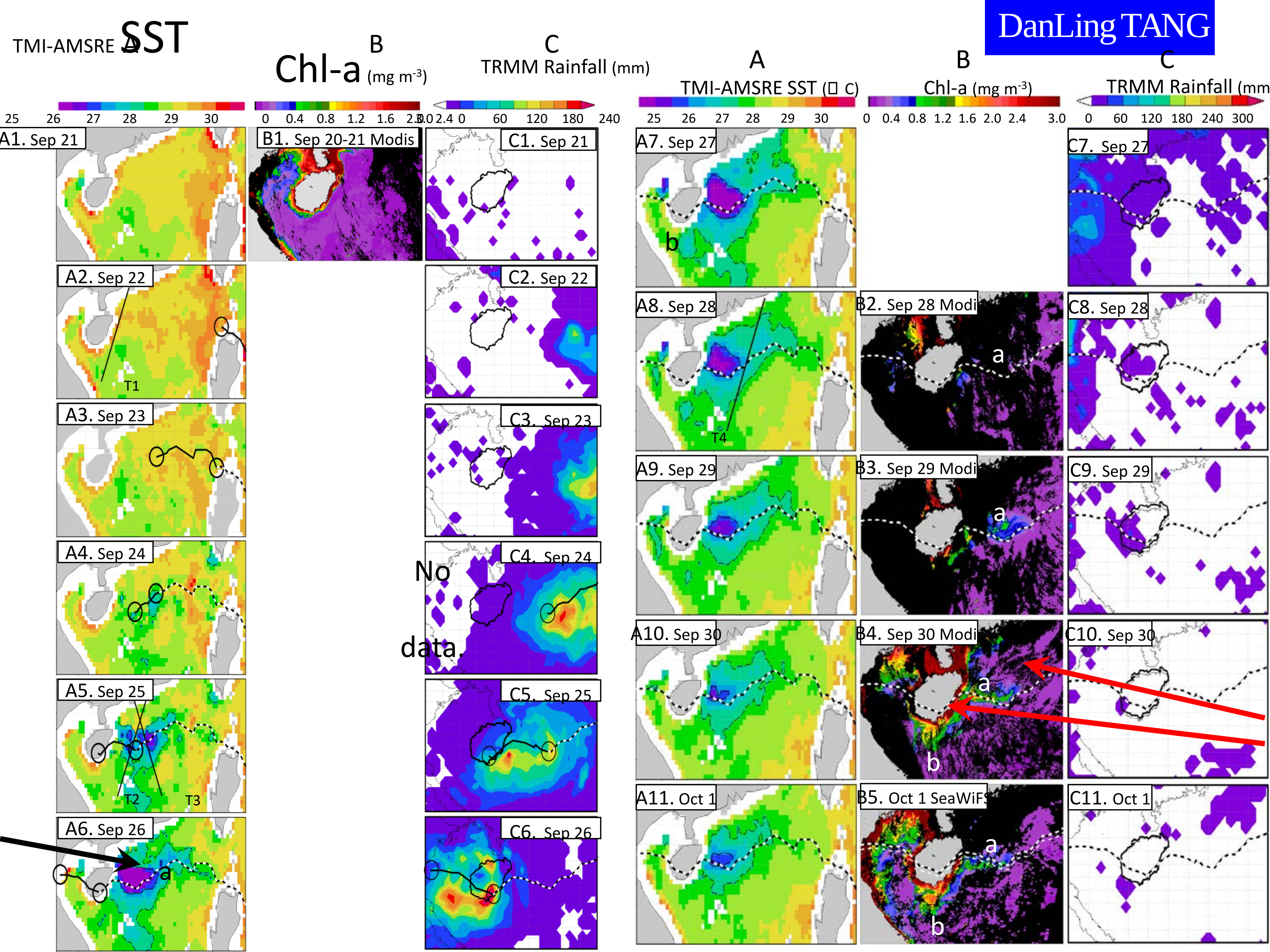


Zheng and Tang, MEPS 2007

Offshore and nearshore chlorophyll increases induced by typhoon and typhoon rain.

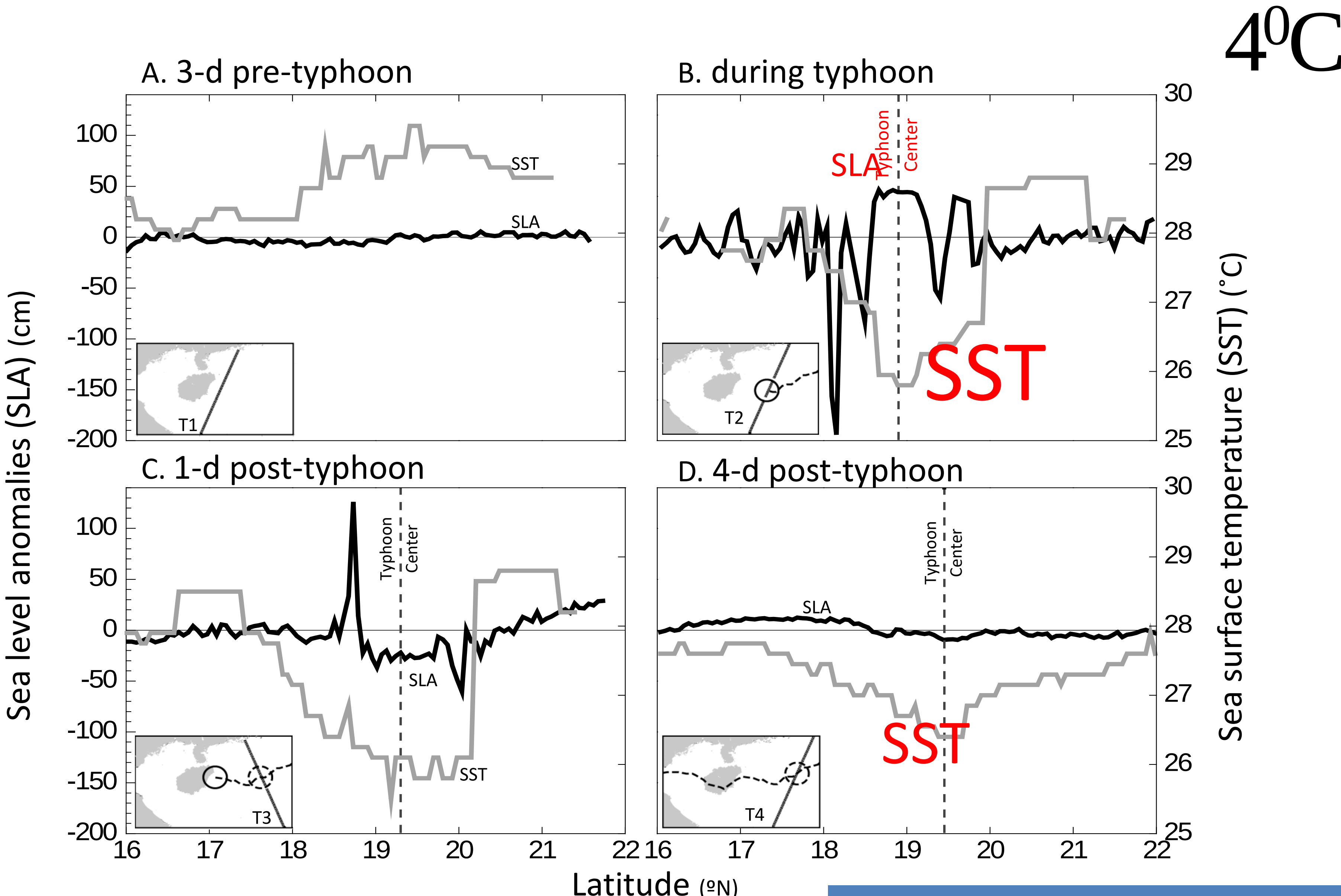


Guangming Zheng and Danling Tang, 2007,
Marine Ecology Progress Series, 333：61-74，2007 (SCI)

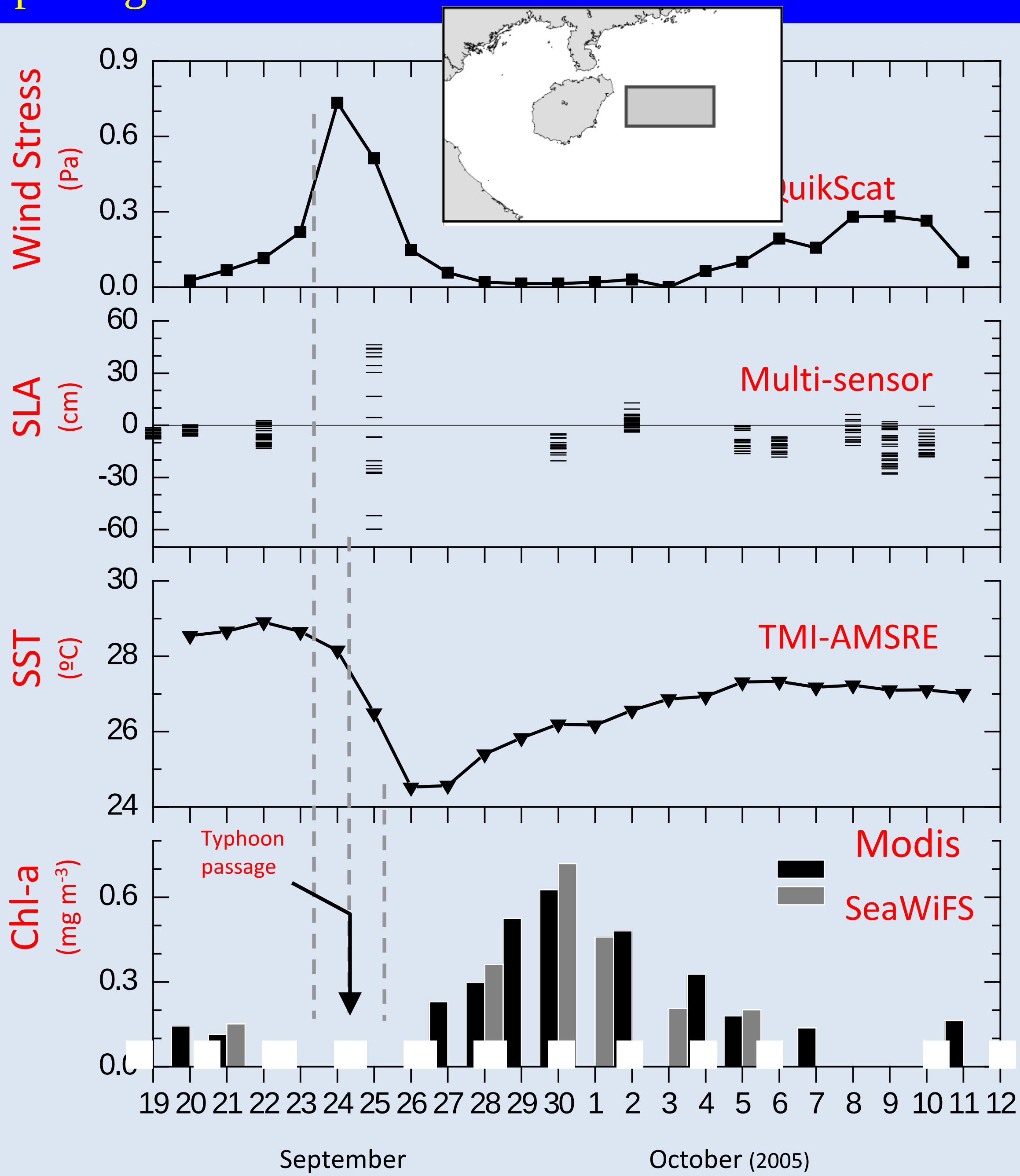


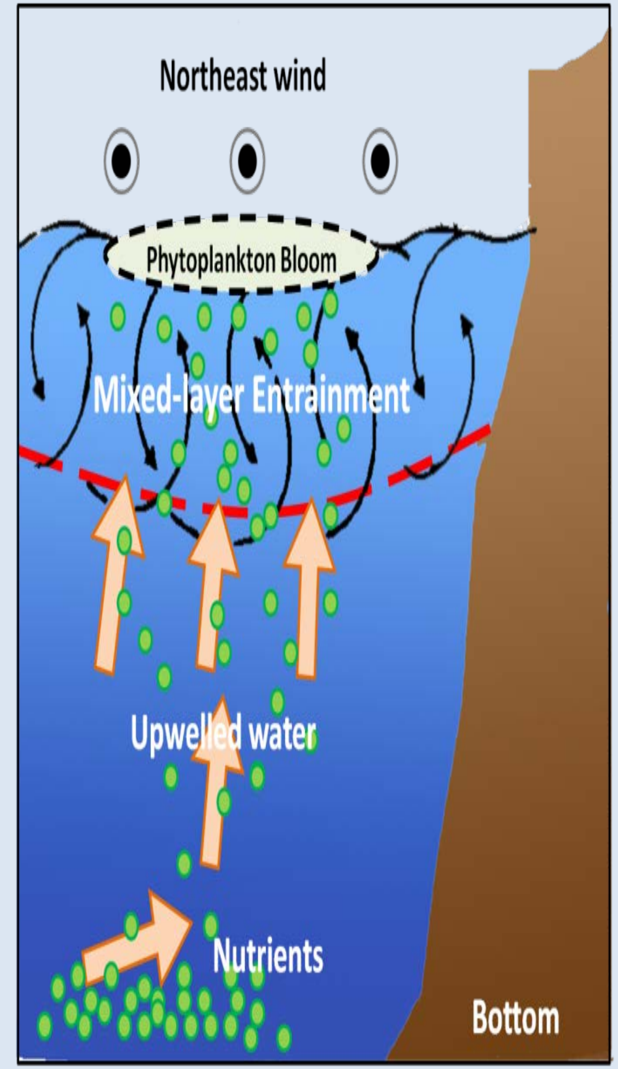
DanLing TANG
TMI-AMSRE A SST
B Chl-a (mg m-3)
C TRMM Rainfall (mm)
25 26 27 28 29 30
0 0.4 0.8 1.2 1.6 2.0 2.4
0 60 120 180 240
A1. Sep 21
B1. Sep 20-21 Modis
C1. Sep 21
A2. Sep 22
T1
C2. Sep 22
A3. Sep 23
C3. Sep 23
A4. Sep 24
No data.
C4. Sep 24
A5. Sep 25
T2
T3
C5. Sep 25
A6. Sep 26
a
C6. Sep 26
A TMI-AMSRE SST (□ C)
B Chl-a (mg m-3)
C TRMM Rainfall (mm)
25 26 27 28 29 30
0 0.4 0.8 1.2 1.6 2.0 2.4 3.0
0 60 120 180 240 300
A7. Sep 27
b
C7. Sep 27
A8. Sep 28
T4
B2. Sep 28 Modi
a
C8. Sep 28
A9. Sep 29
B3. Sep 29 Modi
a
C9. Sep 29
A10. Sep 30
B4. Sep 30 Modi
a
b
C10. Sep 30
A11. Oct 1
B5. Oct 1 SeaWiFS
a
b
C11. Oct 1

Sea level variation & sea surface cooling



Zheng and Tang, MEPS 2007

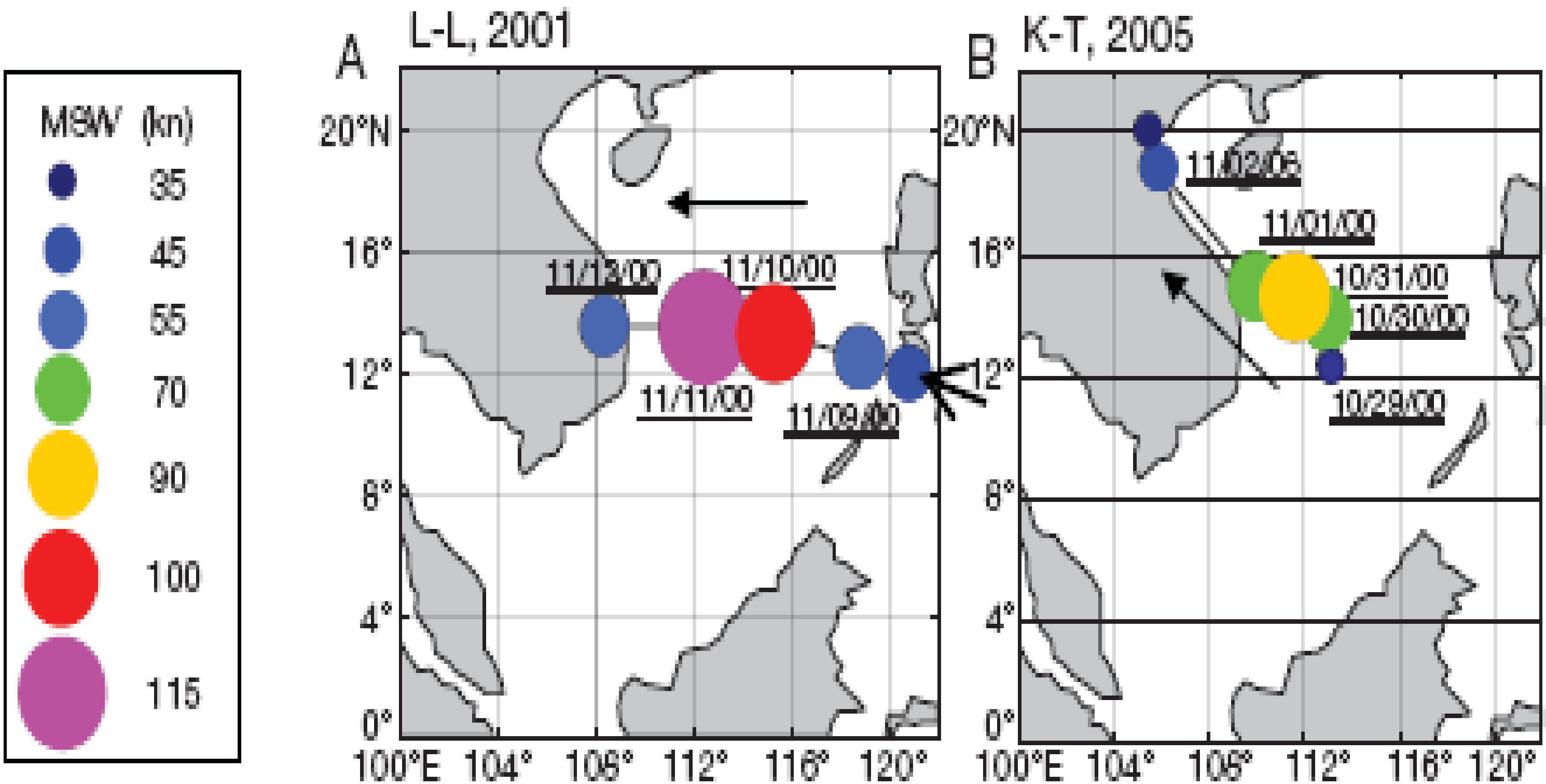




Wind Pump

Zheng and Tang, MEPS 200

- **intensities /Wind Speed?**
- **translation speeds**

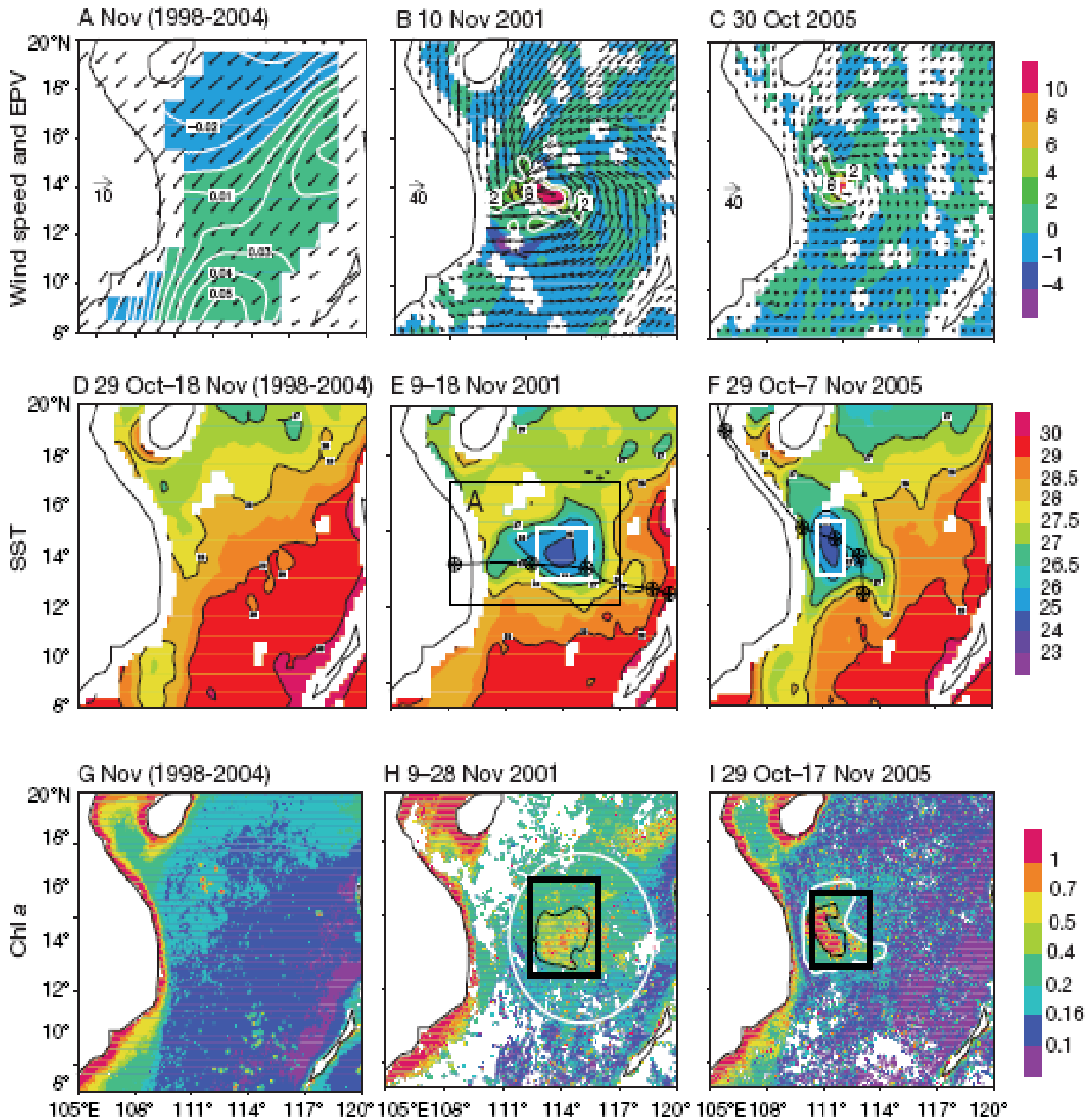


.) Track and intensity of typhoons L-L (2001) and K-T (2005) in the SCS. MSW: maximum sustaine (in knots, 1 kn = 0.514 m s^{-1})

Zhao H, DanLingTang, Wang Y. 2008 MEPS

Tang DanLing 唐丹玲

Strong, fast-moving (4.4m s-1)   Weak, slow moving (2.87 m s-1)   KT



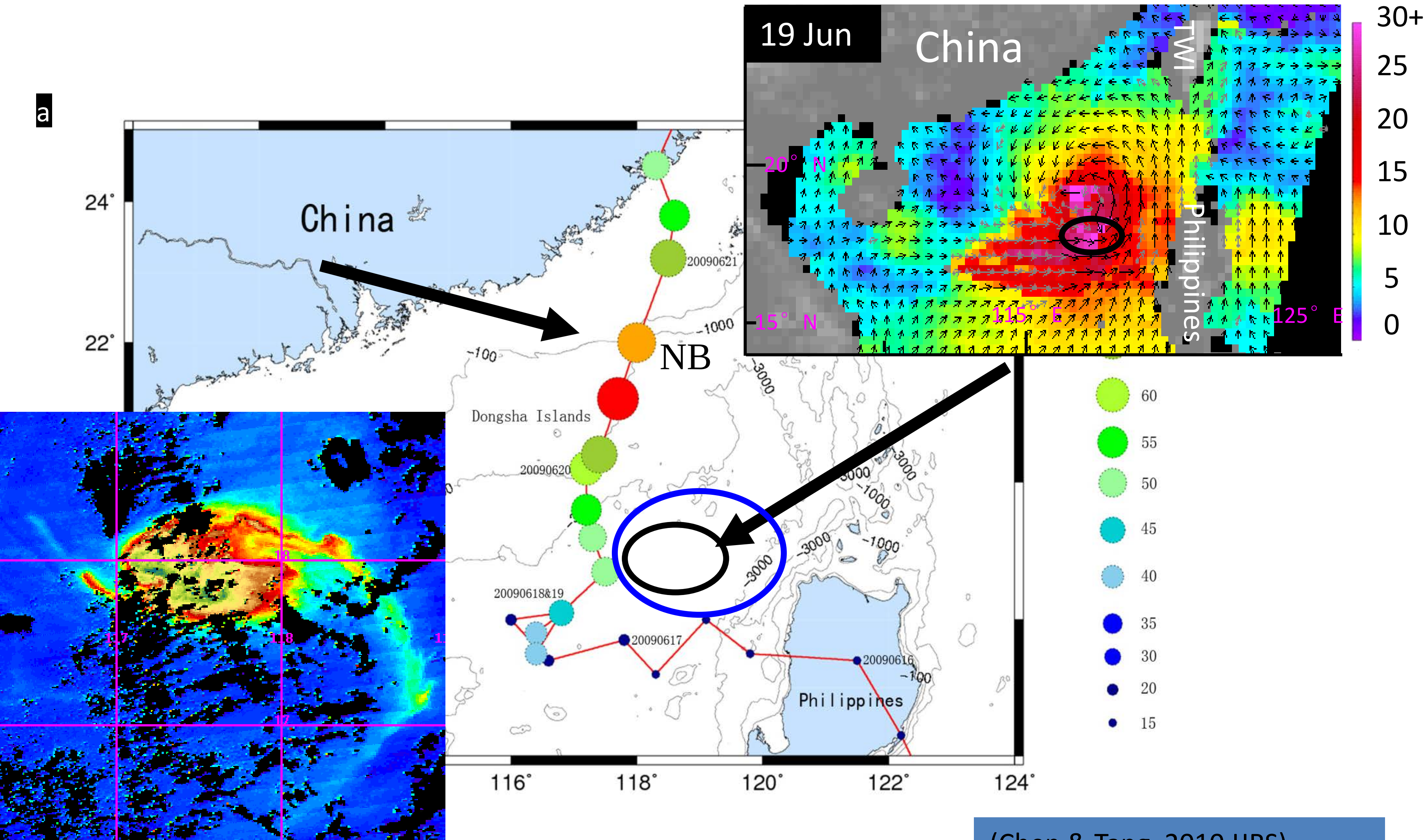
Wind

SST

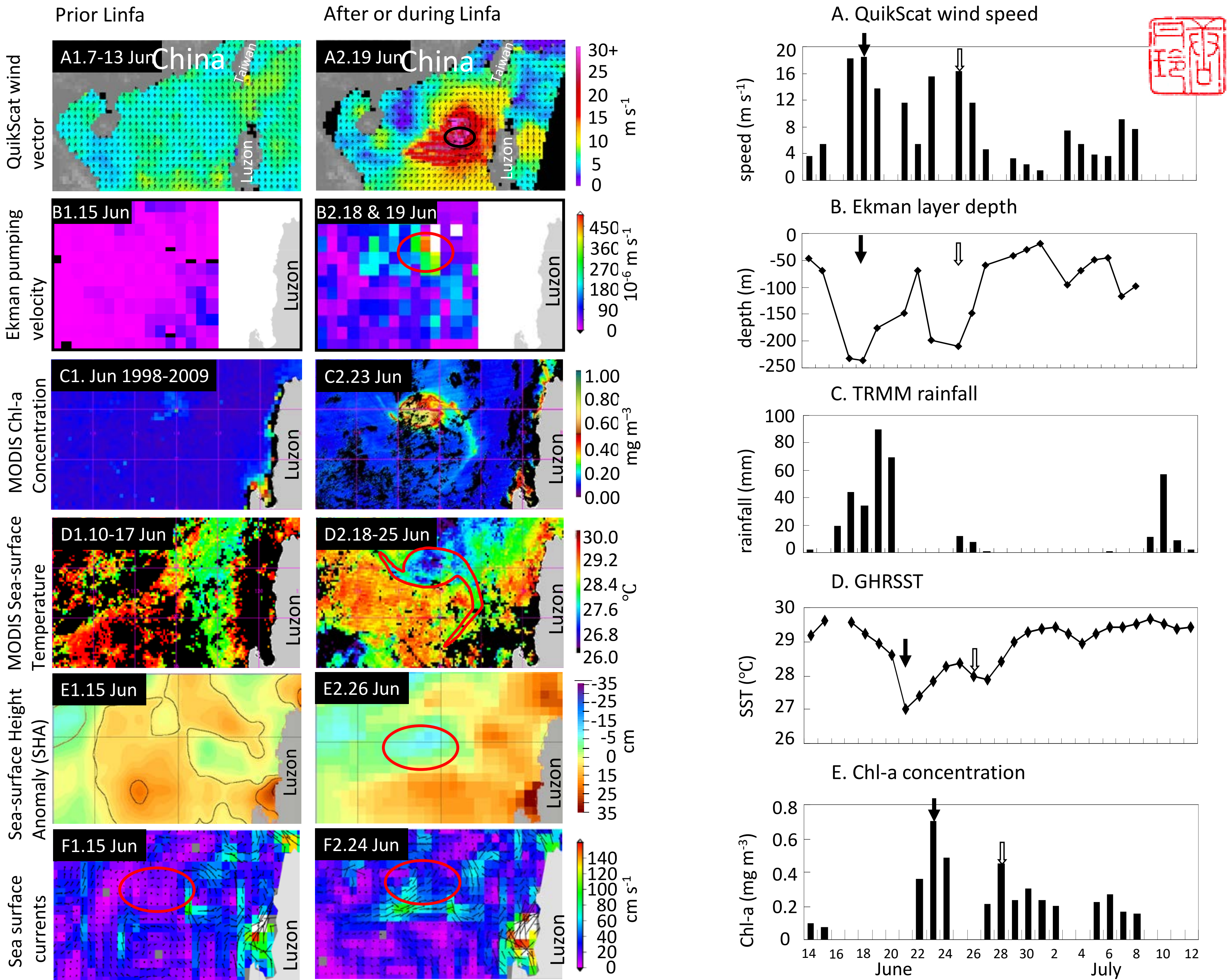
Chl a

MEPS 2008

Eddy-feature phytoplankton bloom induced by tropical cyclone in the South China Sea,

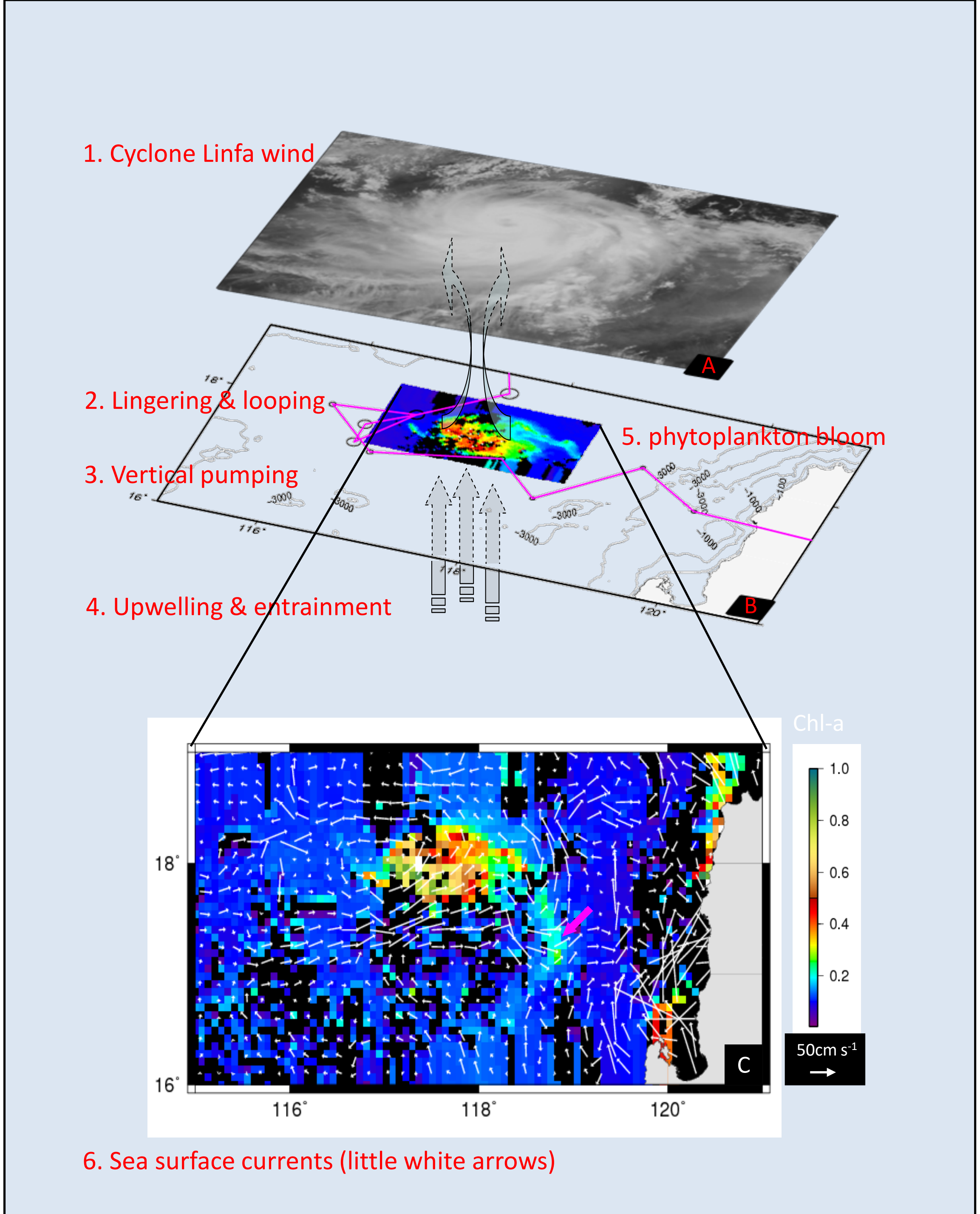


(Chen & Tang, 2010,IJRS)



Prior Linfa
After or during Linfa
QuikScat wind vector
A1.7-13 Jun
China
Taiwan
Luzon
A2.19 Jun
30+
25
20
15
10
5
0
m s-1
Ekman pumping velocity
B1.15 Jun
B2.18 & 19 Jun
450
360
270
180
90
0
10-6 m s-1
MODIS Chl-a Concentration
C1. Jun 1998-2009
C2.23 Jun
1.00
0.80
0.60
0.40
0.20
0.00
mg m-3
MODIS Sea-surface Temperature
D1.10-17 Jun
D2.18-25 Jun
30.0
29.2
28.4
27.6
26.8
26.0
°C
Sea-surface Height Anomaly (SHA)
E1.15 Jun
E2.26 Jun
-35
-25
-15
-5
0
15
25
35
cm
Sea surface currents
F1.15 Jun
F2.24 Jun
140
120
100
80
60
40
20
0
cm s-1
A. QuikScat wind speed
speed (m s-1)
B. Ekman layer depth
depth (m)
C. TRMM rainfall
rainfall (mm)
D. GHRSST
SST (°C)
E. Chl-a concentration
Chl-a (mg m-3)
14 16 18 20 22 24 26 28 30 2 4 6 8 10 12
June
July

Satellite data on Wind Pump



typhoon
Wind Pump

Energy Transfer

4 Wind pump effects on marine ecosystem

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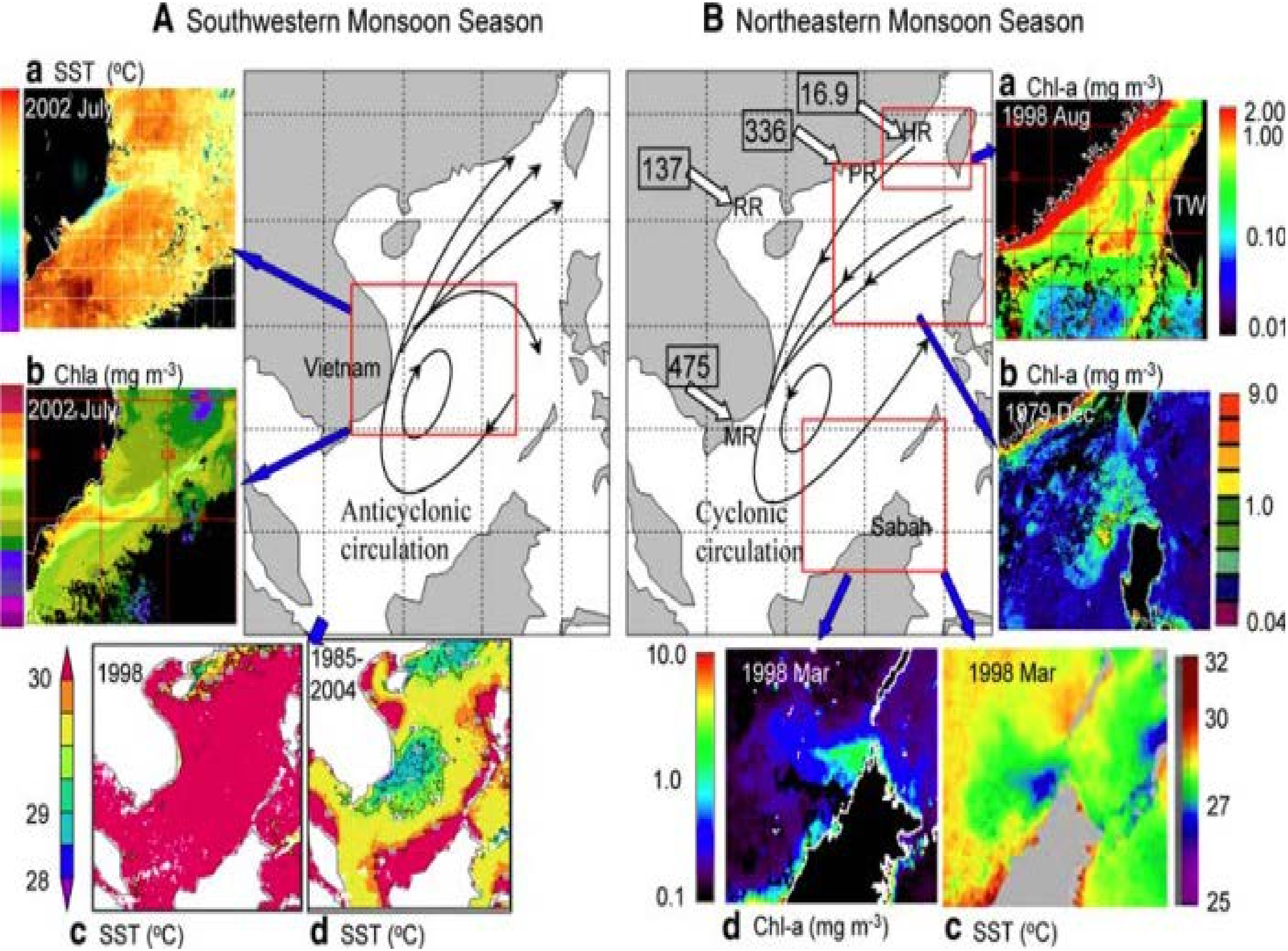
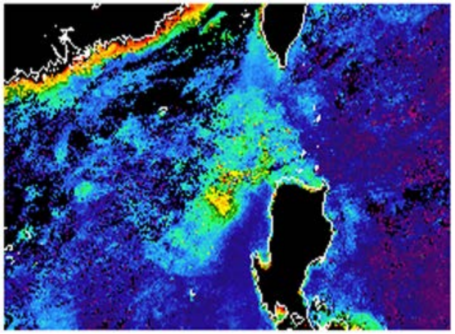
Available online at www.sciencedirect.com
ScienceDirect
Advances in Space Research 53 (2014) 1081–1091
ADVANCES IN SPACE RESEARCH
(a COSPAR publication)
www.elsevier.com/locate/asr

Response of dissolved oxygen and related marine ecological parameters to a tropical cyclone in the South China Sea

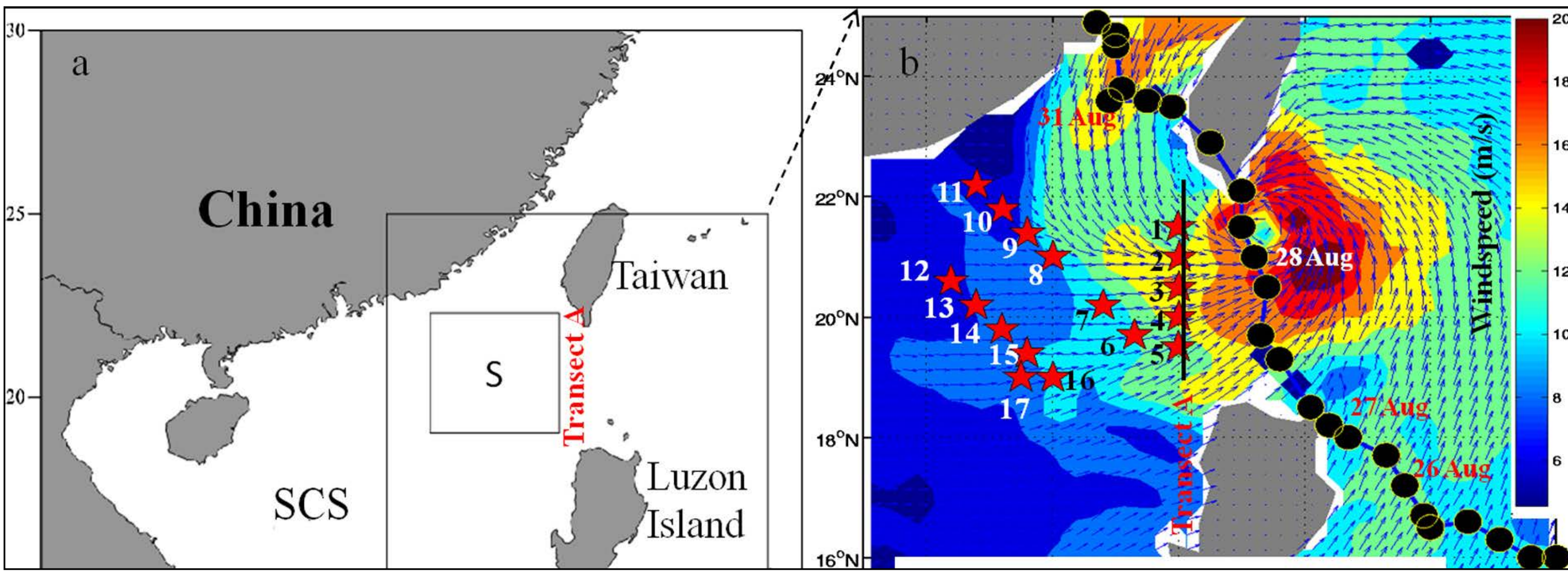
Jingrou Lin [a,b,c], Danling Tang [a,b,*], Werner Alpers [d], Sufen Wang [a]



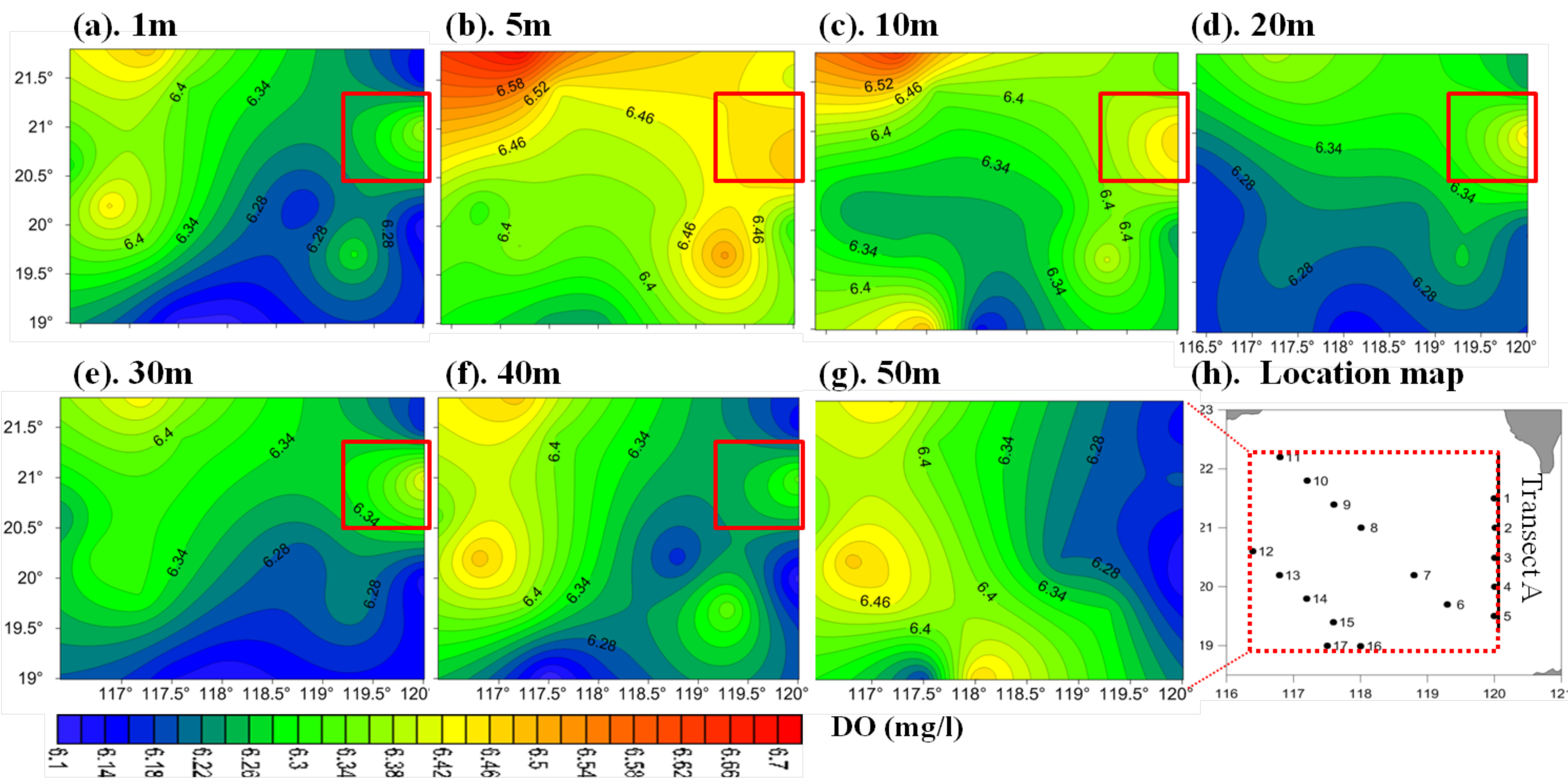
A Southwestern Monsoon Season
B Northeastern Monsoon Season
a SST (ºC)
2002 July
b Chla (mg m-3)
2002 July
Vietnam
Anticyclonic circulation
1998
1985-2004
30
29
28
c SST (ºC)
d SST (ºC)
16.9
336
137
HR
PR
RR
475
MR
Cyclonic circulation
Sabah
a Chl-a (mg m-3)
1998 Aug
TW
2.00
1.00
0.10
0.01
b Chl-a (mg m-3)
1979 Dec
9.0
1.0
0.04
10.0
1.0
0.1
1998 Mar
1998 Mar
32
30
27
25
d Chl-a (mg m-3)
c SST (ºC)



the super-typhoon Nanmadol
on 22 - 30 August 2011,



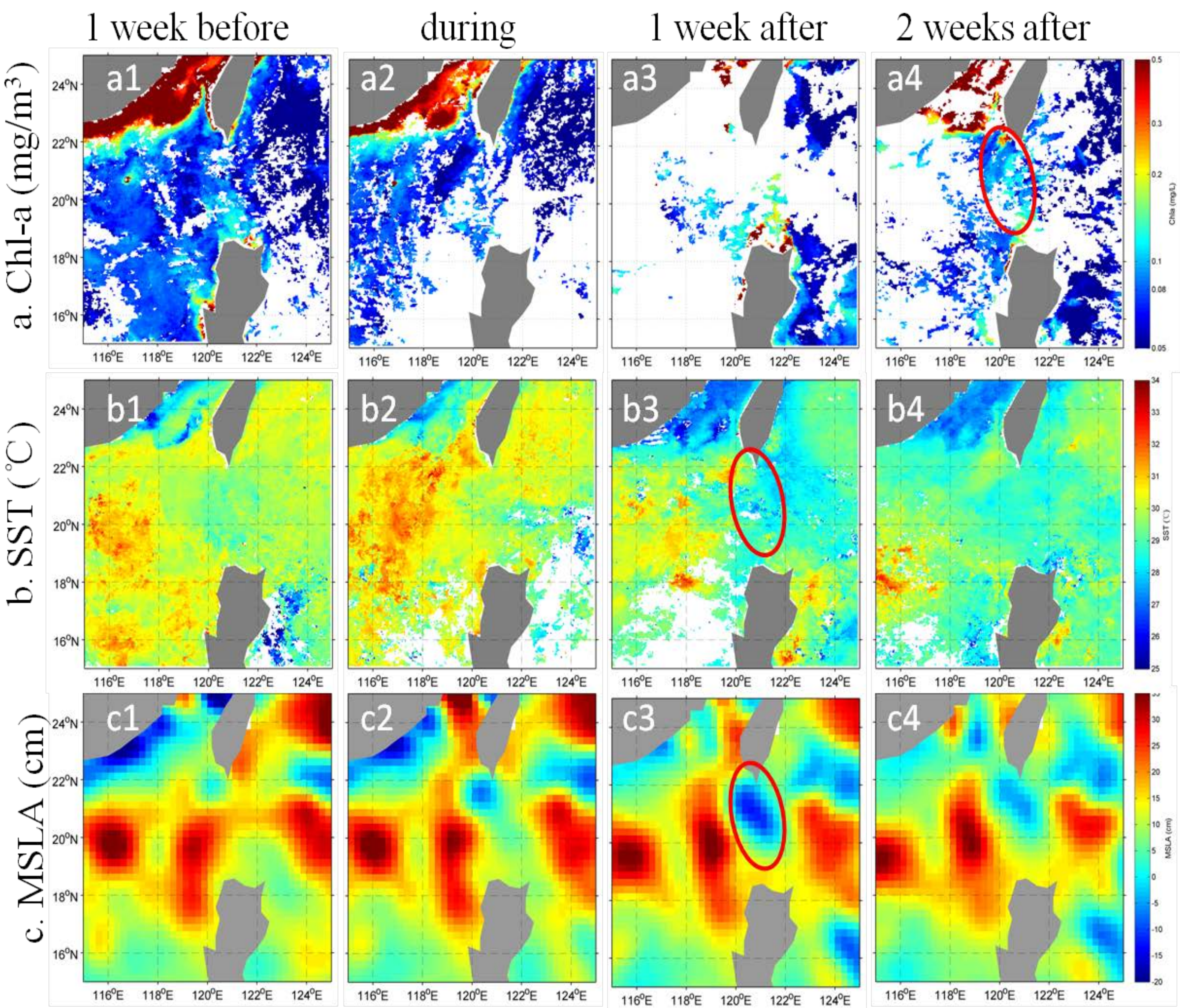
Horizontal distribution of DO concentration



(in mg l1) at different depths at 19–22N, 116–120E (a–g).

Jingrou Lin, Danling Tang*， Werner Alpers, Sufen Wang， 2014. Advances in Space Research。 http://dx.doi.org/10.1016/j.asr.2014.01.005

Horizontal distribution



The Chl-a (mg m3)

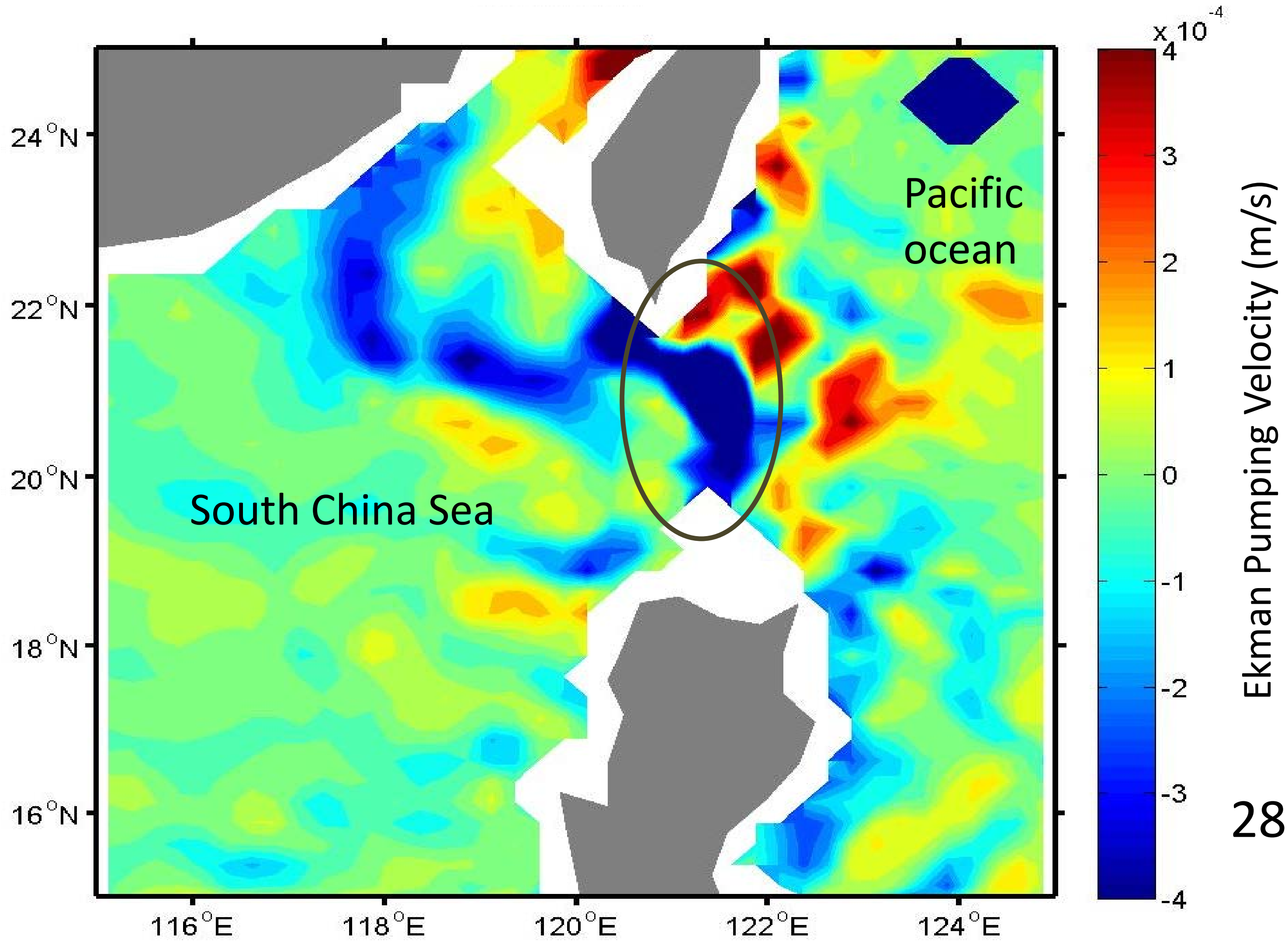
8-day composites retrieved from MODIS data

SST (C)

SLA (cm) weekly

retrieved from altimeter data

Daily averaged Ekman pumping velocity (m s1)



28 Aug 2011.

Fig.7

Sea surface current (m s1),

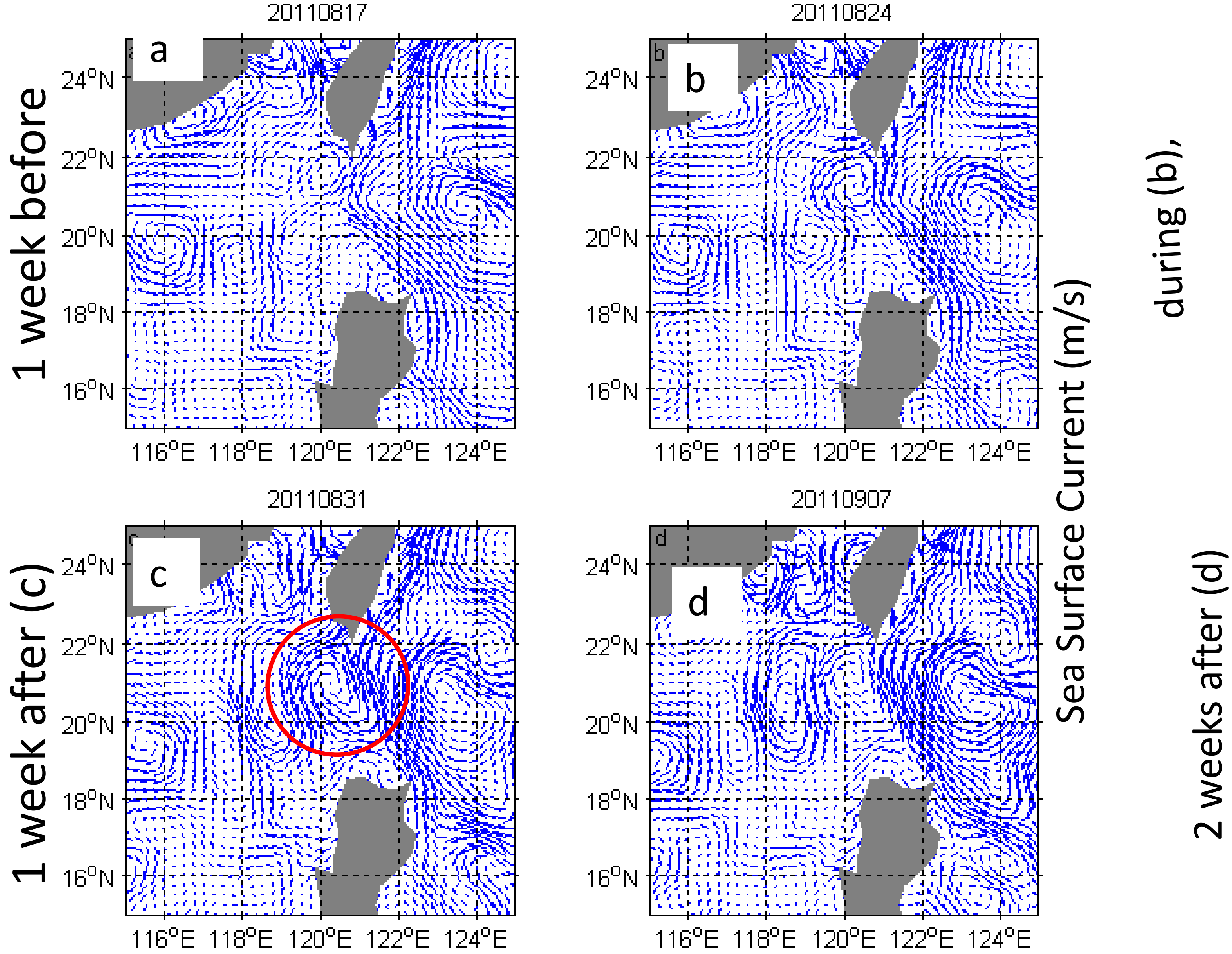


Fig.8

Enhanced sea-air CO_2 exchange

influenced by a tropical depression

in the South China Sea

QY SUN, DL TANG, Louis Legendre, P Shi, GJR, 2014

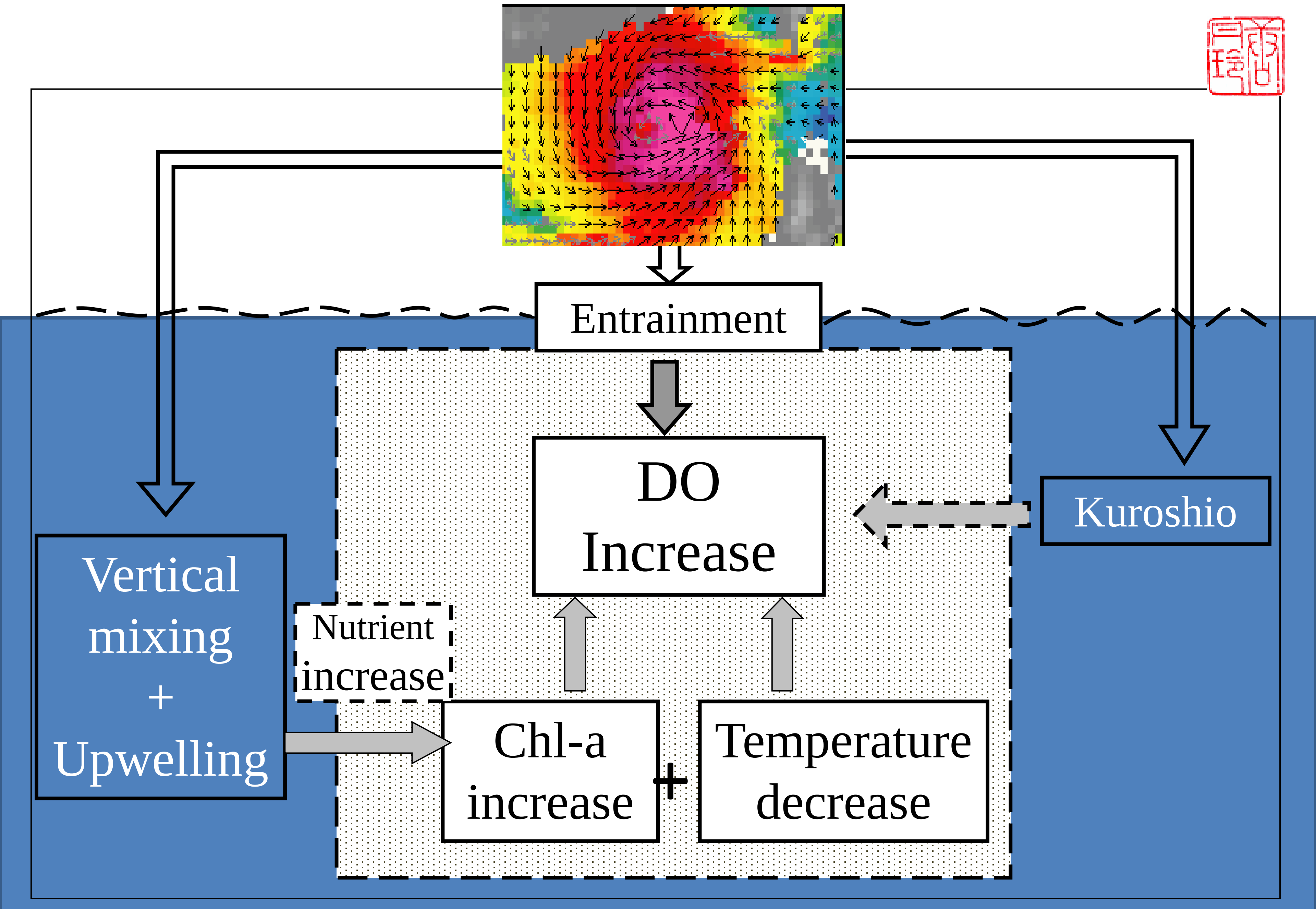
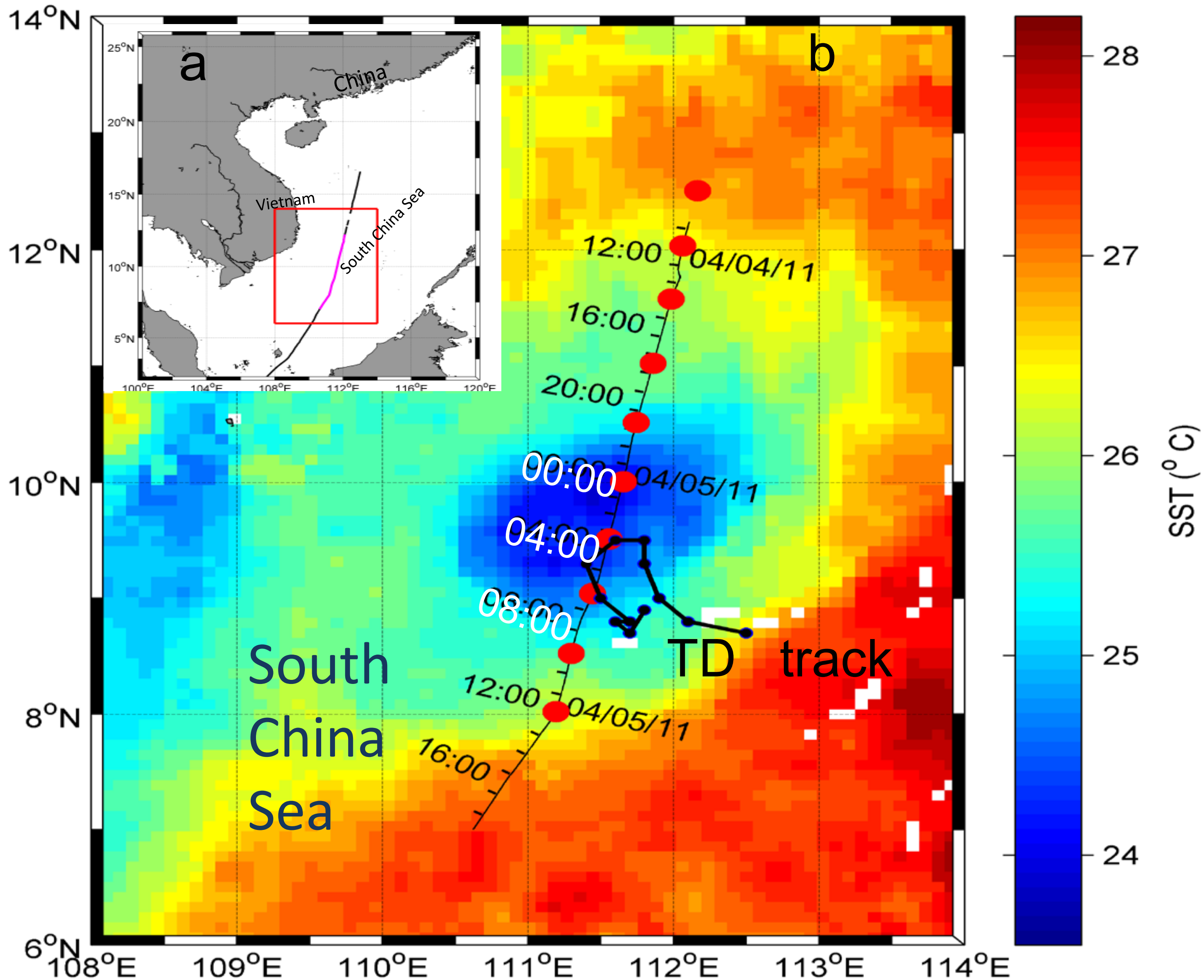

Entrainment
DO
Increase
Kuroshio
Vertical
mixing
+
Upwelling
Nutrient
increase
Chl-a
increase
+
Temperature
decrease

Fig.9

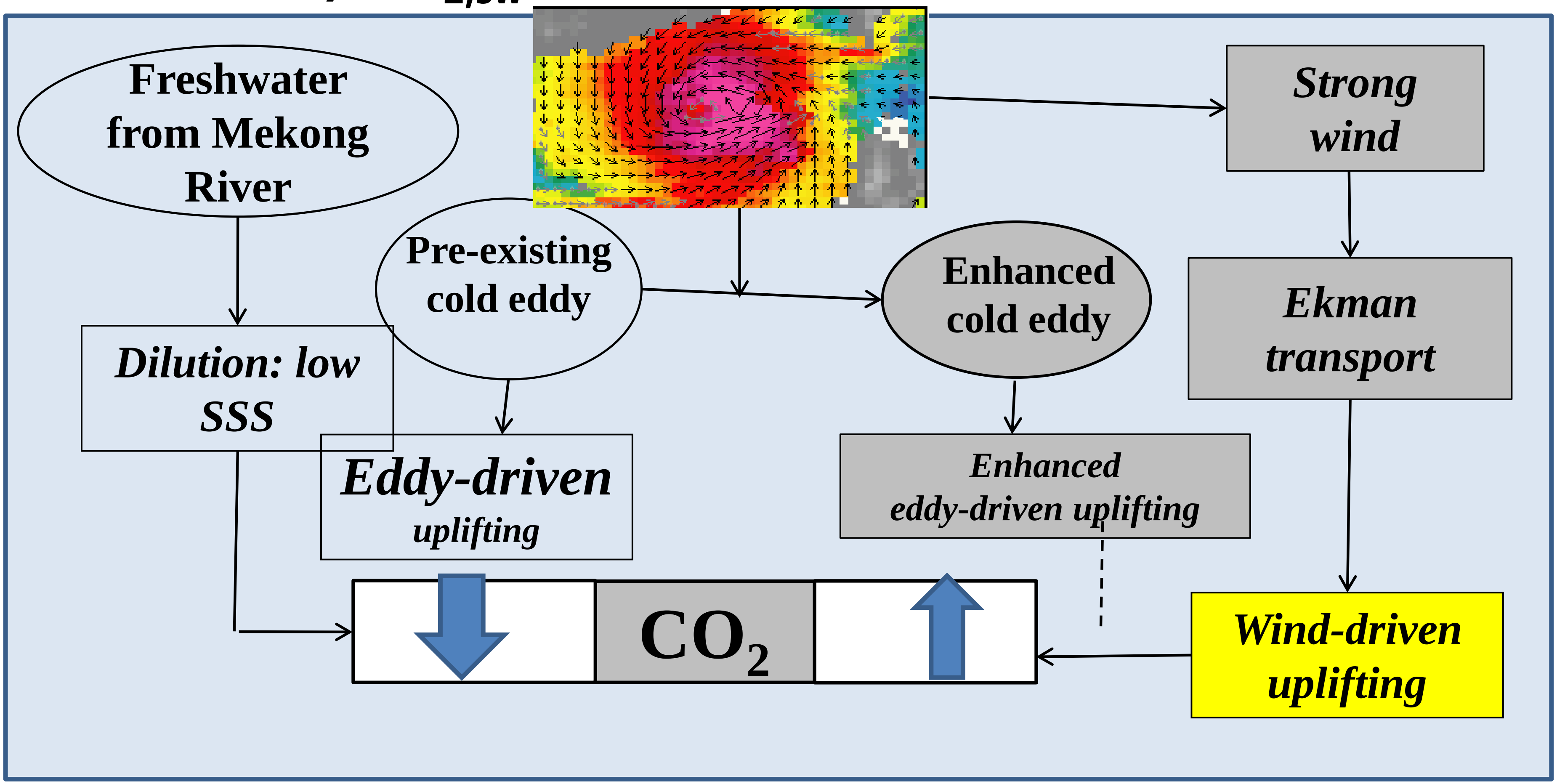
A tropical depression (TD) in the SCS



April 2011

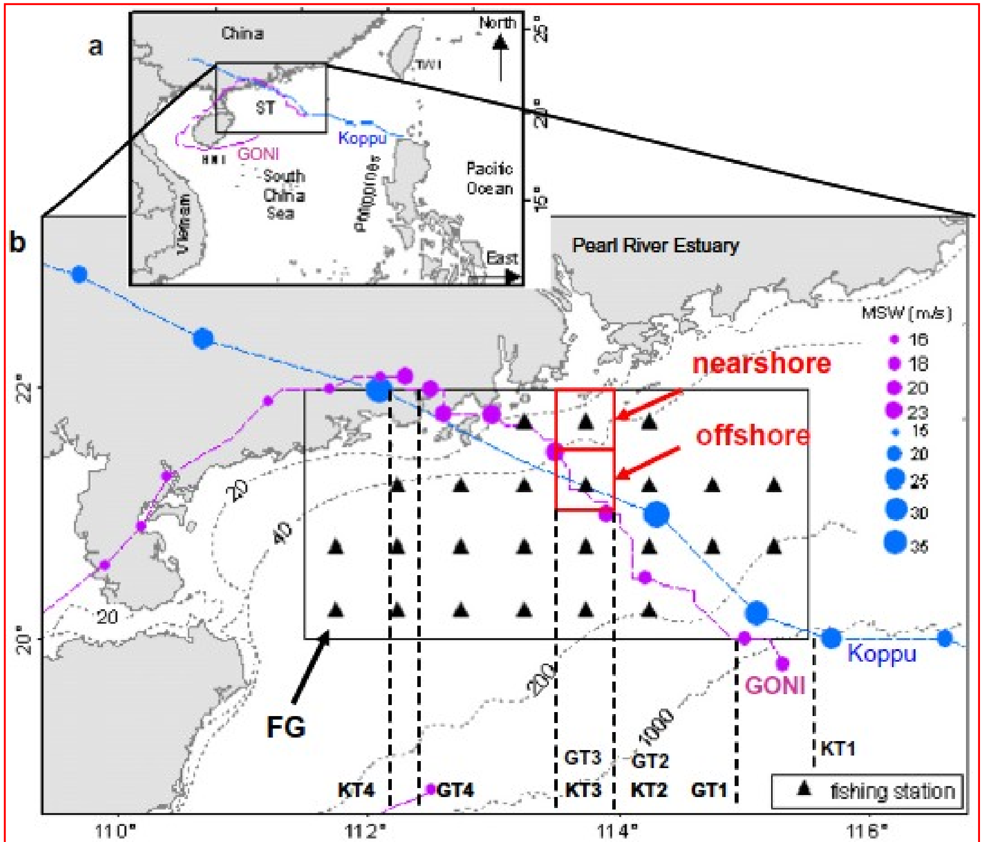
1. Surface water diluted by heavy rain, with low $pCO_{2,sw}$

2. TD uplifting eddy-driven high $pCO_{2,sw}$



change temporarily

(1) Increase in fish abundance during two typhoons in the South China Sea



GONI: 20:00 Aug 3(Begin)-14:00 Aug 9(End)

Koppu: 02:00 Sep 13(Begin)-05:00 Sep 16(End)

GT4: 13:00 Aug 5 KT4: 08:00 Sep 15

GT3: 20:00 Aug 4 KT3: 01:00 Sep 15

GT2: 13:00 Aug 4 KT2: 20:00 Sep 14

GT1: 02:00 Aug 4 KT1: 09:00 Sep 14

ELSEVIER
Available online at www.sciencedirect.com
SciVerse ScienceDirect
Advances in Space Research 51 (2013) 1734–1749
ADVANCES IN SPACE RESEARCH (a COSPAR publication)
www.elsevier.com/locate/asr

Increase in fish abundance during two typhoons in the South China Sea

Jie Yu[a,b,c], Danling Tang[a,c,*], Yongzhen Li[b], Zirong Huang[b], Guobao Chen[b]

Yu & Tang, 2013, ASR

②species number

No	1	2	3	4 to 8	9	10	11	12	13	14	15	16	17	18	19	20
e7		√									√					
s3		√						√								
s4		√						√							√	√
s5		√						√	√	√	√	√	√	√	√	√
s7		√						√	√	√	√	√	√	√	√	√
s8		√						√	√	√	√	√	√	√	√	√
s10		√						√							√	
s11		√		G				√	√						√	√
s12		√		O				√			√					
s13		√		N				√	√	√	√	√	√	√	√	
s14		√		I				√	√	√	√	√	√		√	√
s15		√						√				√	√		√	√
s16		√						√			√		√		√	√
s21		√						√				√			√	√
s22		√						√		√		√	√	√	√	
o1		√						√	√	√	√	√	√	√	√	
o4		√						√							√	
o5		√						√	√	√	√	√	√	√	√	√
s9		√														
e1								√								
e2								√								
e6								√							√	√
s6		Increased						√	√				√	√		√
s17		records						√		√					√	√
s18								√							√	√
s19								√								√
s20								√			√				√	√
o3								√				√	√		√	√

No	1	2	3	4	5	6	7	8	9	14 to 15	16	17	18	19	20	25	26
s5	√		√						√		√	√	√	√	√	√	√
s8	√								√		√	√	√	√	√		√
s11	√		√						√		√	√	√	√	√		√
s13	√		√						√	K		√	√	√			
s14	√		√						√	o	√	√	√	√	√		
s16	√		√						√		√	√	√				√
s17	√		√							p		√	√				
s21	√									p	√	√	√	√	√		√
o1			√						√	u	√	√	√				
o5	√		√						√		√	√	√	√	√		√
e2												√					
e3													√				
e5												√	√				√
e6												√	√	√	√		
e7											√	√	√	√	√		√
s2											√						
s3											√	√	√	√			
s4											√	√	√	√		√	
s6												√	√				
s7								Increased			√	√	√	√			
s10								records			√	√	√	√			
s12												√	√	√	√		
s15												√	√	√			
s18											√	√	√				
s19												√	√				
s20												√	√	√			
s22											√	√	√	√	√		
o3											√	√	√	√	√		
o4												√	√	√	√		

New records

Yu & Tang, 2013, ASR

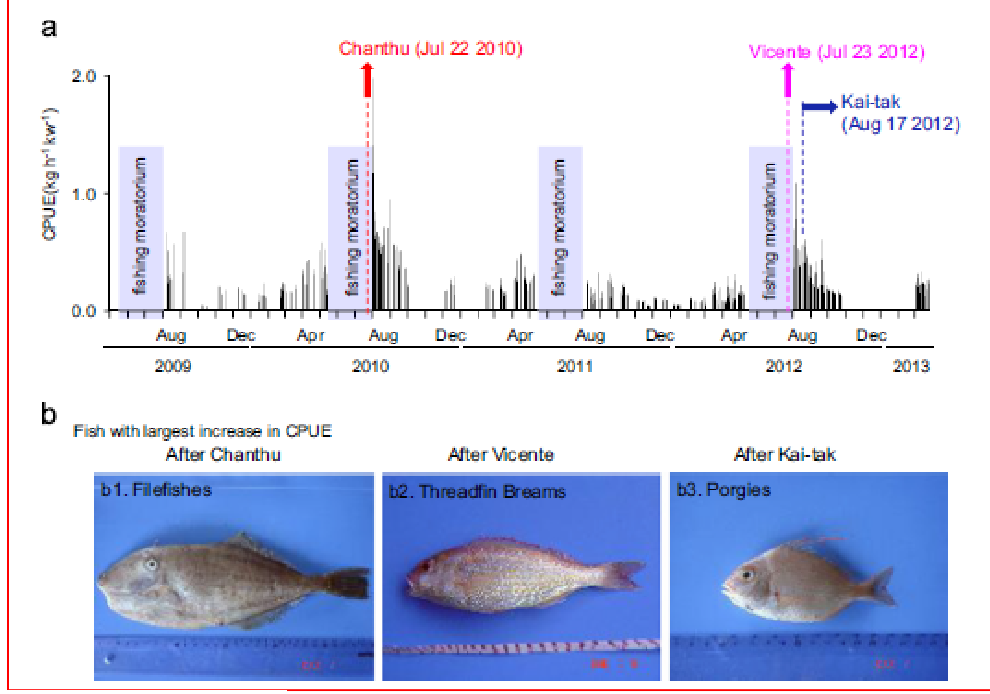
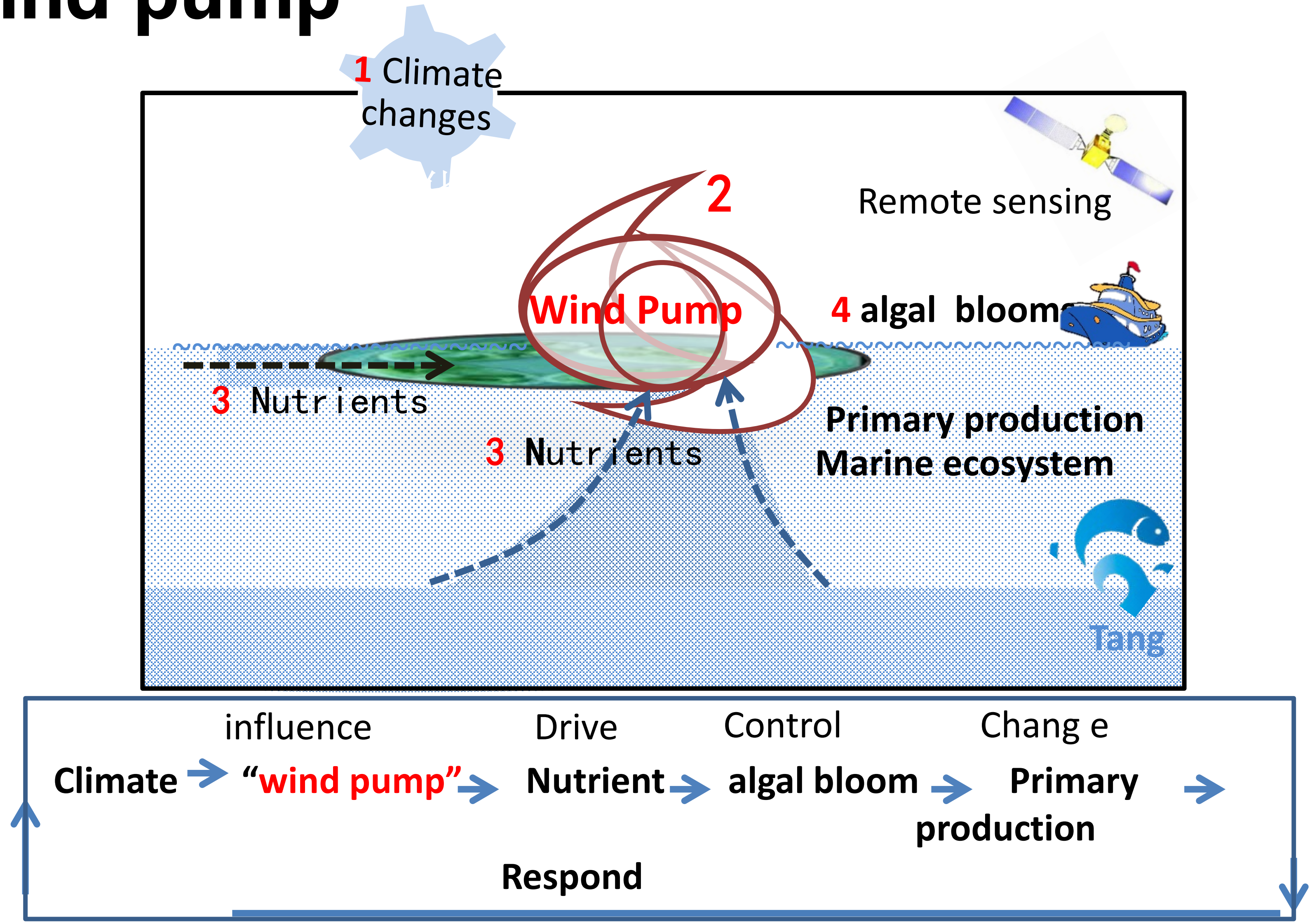


Table 1
Information of 30 main fishes sampled in the area.

No	Common name	Description	Habitat depth	Tropical level
1	Pelagic scad	*Decapterus* spp. dominated by *D. maruadsi*	Pelagic	Low class carnivorous fish
2	Ponyfish	*Leiognathus* spp. dominated by *L. bindus* and *L. elongatus*	Pelagic	Low class carnivorous fish
3	Pomfret	*Pampus* spp. dominated by *P. argenteus* and *P. chinensis*, and *Parastromateus niger*	Pelagic	Low class carnivorous fish
4	Chub mackerel	A single species of *Scomber japonicus*	Pelagic	Low class carnivorous fish
5	Spanish mackerel	*Scomberomorus* spp. dominated by *S.guttatus* and *S.commerson*	Pelagic	High class carnivorous fish
6	Spinyhead croaker	*Collichthys* spp. dominated by a *Collichthys lucidus*	Meso demersal	Low class carnivorous fish
7	Jewfish	*Johnius* spp. dominated by *J. dussumieri* and *J. belangerii*	Meso demersal	Low class carnivorous fish
8	Yellow drum	a single species of *Nibea albiflora*	Meso demersal	Low class carnivorous fish
9	Silver croaker	*Pennahia argentatus*	Meso demersal	Low class carnivorous fish
10	Grouper	*Epinephelus* spp. dominated by *E. akaara* and *E. awoara*	Meso demersal	Middle class carnivorous fish
11	Red barracuda	a single species of *Sphyraena pinguis*	Meso demersal	High class carnivorous fish
12	Hairtail	*Trichiurus* spp. dominated by *T. lepturus*	Meso demersal	High class carnivorous fish
13	Pacific rudderfish	a single species of *Psenopsis anomala*	Demersal	Low class carnivorous fish
14	Threadfin bream	*Nemipterus* spp. dominated by *N. virgatus*	Demersal	Low class carnivorous fish
15	Porgies	a single species of *Parargyrops edita*	Demersal	Low class carnivorous fish
16	Bigeye	*Priacanthus* spp. dominated by *P. tayenus* and *P. macracanthus*	Demersal	Low class carnivorous fish
17	Filefish	Thamnaconus spp. dominated by *T. hypargyreus*	Demersal	Low class carnivorous fish
18	Goatfish	Upeneus spp. dominated by *U. moluccensis* and *U. sulphureus*	Demersal	Low class carnivorous fish
19	Tonguesole	*Cynoglossus* spp.	Demersal	Low class carnivorous fish
20	Sillago	*Sillago sihama* and *S. japonica*	Demersal	Low class carnivorous fish
21	Monkfish	*Lophius* spp. dominated by *Lophius litulon*	Demersal	Middle class carnivorous fish
22	Snakefish	a single species of *Trachinocephalus myops*	Demersal	Middle class carnivorous fish
23	Conger pike	*Muraenesox cinereus*	Demersal	High class carnivorous fish
24	Lizardfish	*Saurida* spp. dominated by *S. tumbil* and *S. undosquamis*	Demersal	High class carnivorous fish
25	White-spotted spinefoot	*Siganus* spp. dominated by *Siganus oramin*	Reef	Omnivorous fish
26	Octopus	*Octopus* spp.	Cephalopoda	Low class carnivorous fish
27	Squid	*Loligo* spp.	Cephalopoda	Low class carnivorous fish
28	Cuttlefish	*Sepia* spp.	Cephalopoda	Low class carnivorous fish
29	Crab	*Portunus* spp. and *Charybdis* spp.	Crab	Low class carnivorous fish
30	Shrimp	*Penaeidae*	Shrimp	Low class carnivorous fish

Wind pump



Wind driven algal bloom in the open oceans

能量传递

“Wind pump”

- Is a series of processes driven by wind that influence ocean currents and water movement which subsequently affects ocean’s ecological status.

“Wind pump”

- Is to change the transport of nutrients, promote the cycling of major elements in the ocean, thus drive primary production and marine ecosystem and affect carbon fixation and global fishery resources.

5

Remote sensing ecology

surface size structure

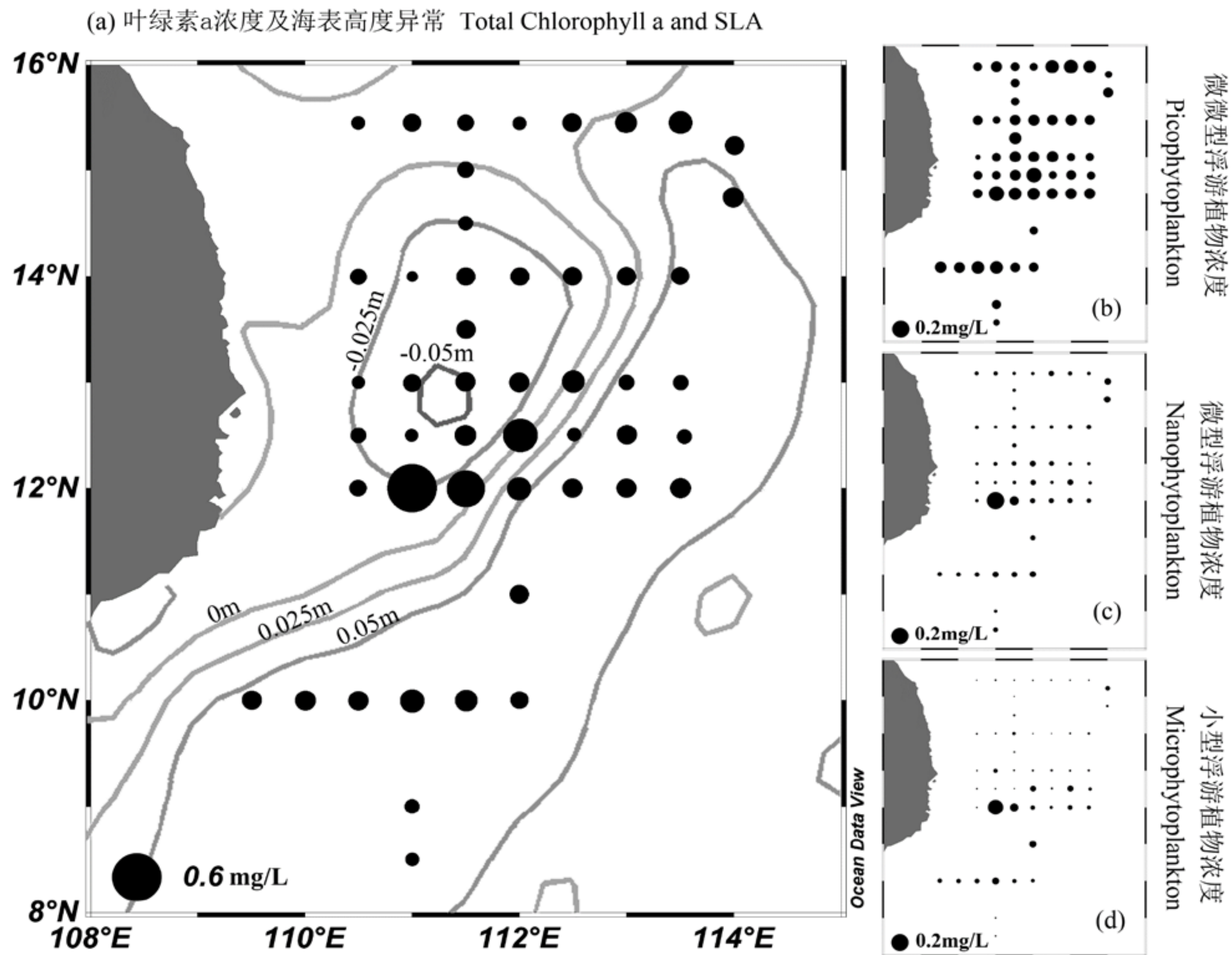


Fig.4 Distribution of (a) Total chlorophyll a concentration merged with SLA (Sep. 2014); surface concentration of (b)picophytoplankton; (c)Nanophytoplankton; (d)Microphytoplankton during in situ observation.

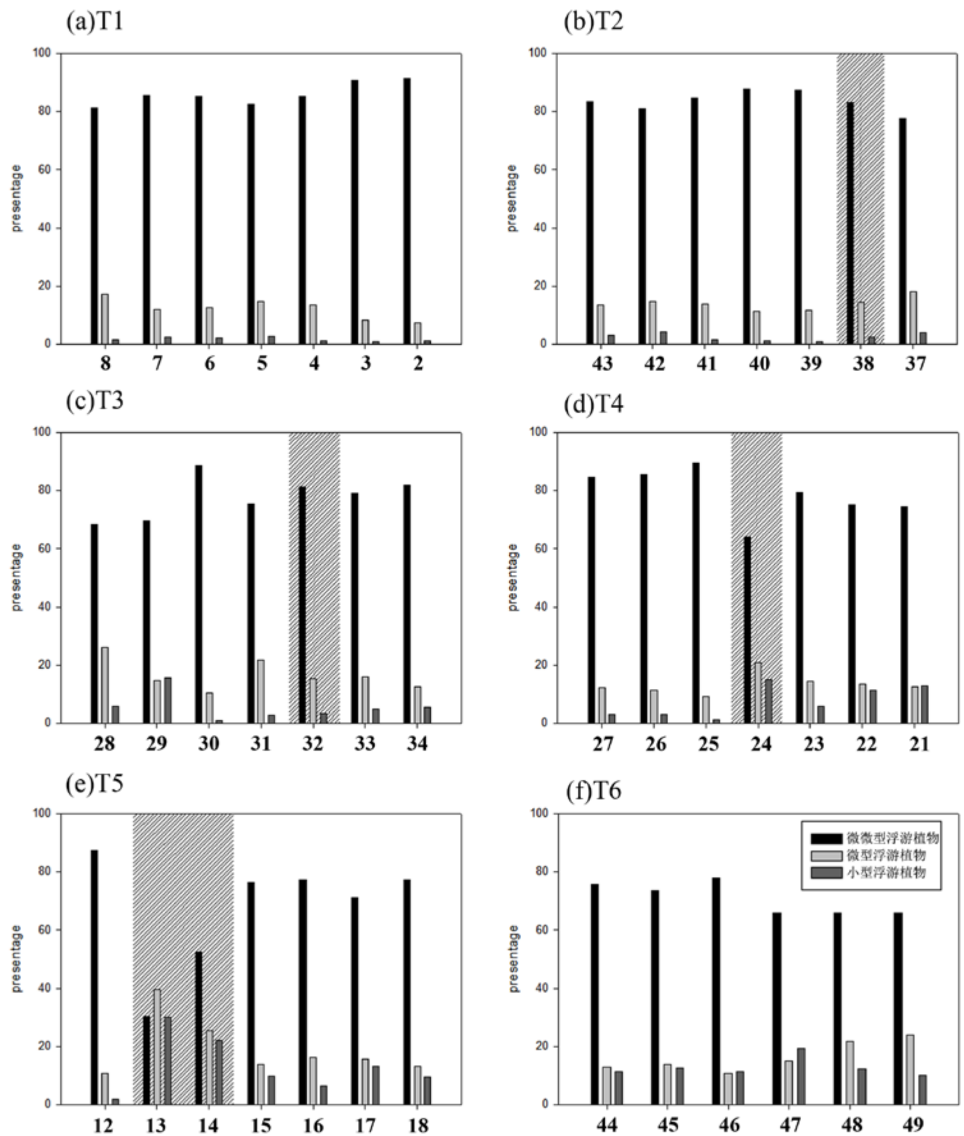


图5 断面（a）T1、（b）T2、（c）T3、（d）T4、（e）T5、（f）T6 上各站点表层不同粒径大小占总叶绿素的比例。灰色背景表示急流区域。

Fig.5 Percentage contribution of various size fractions of phytoplankton to the total chlorophyll in surface of (a)T1, (b)T2, (b)T3, (d)T4, (e)T5, (f)T6. Background in grey represents stations in jet area.

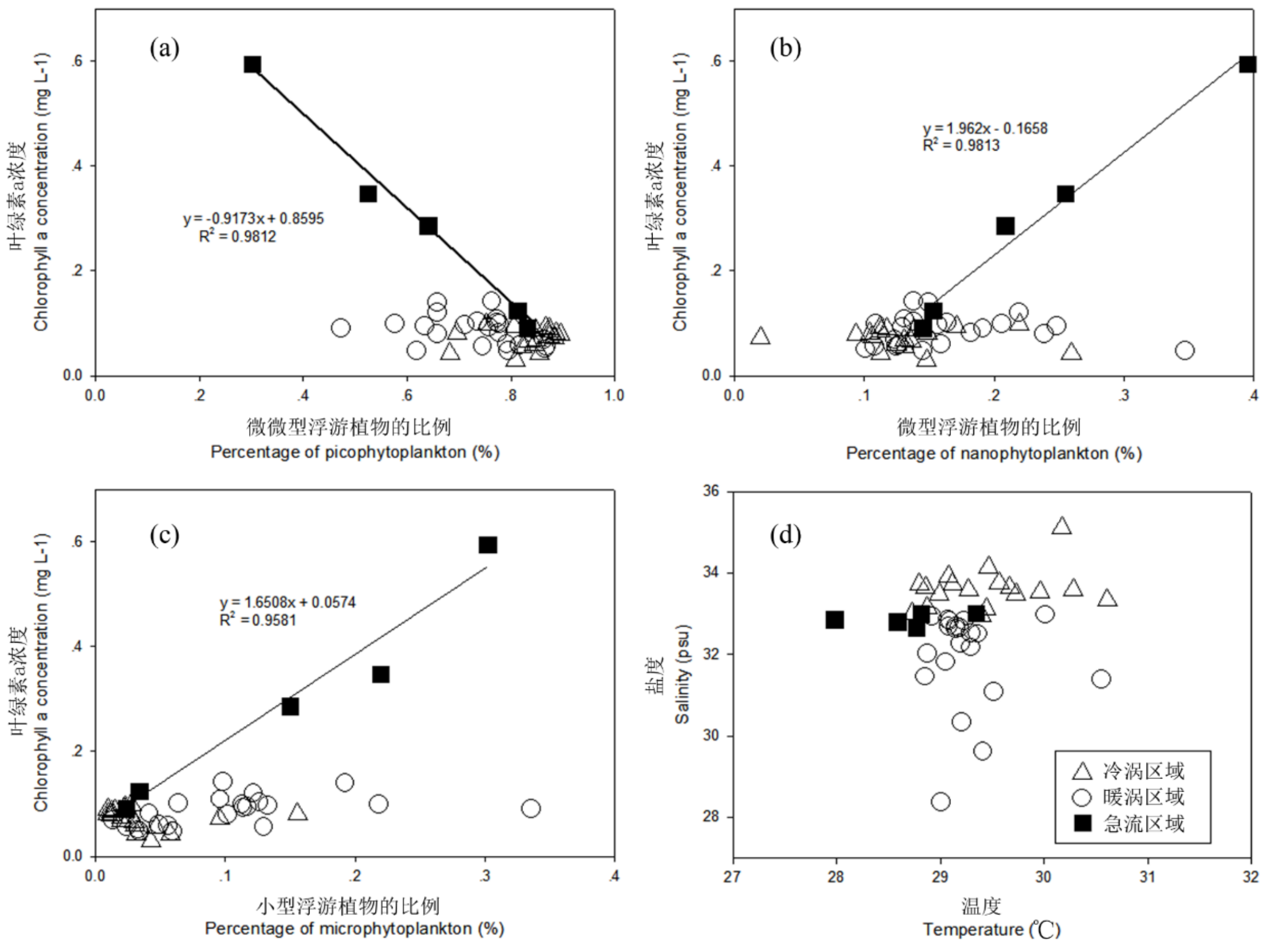
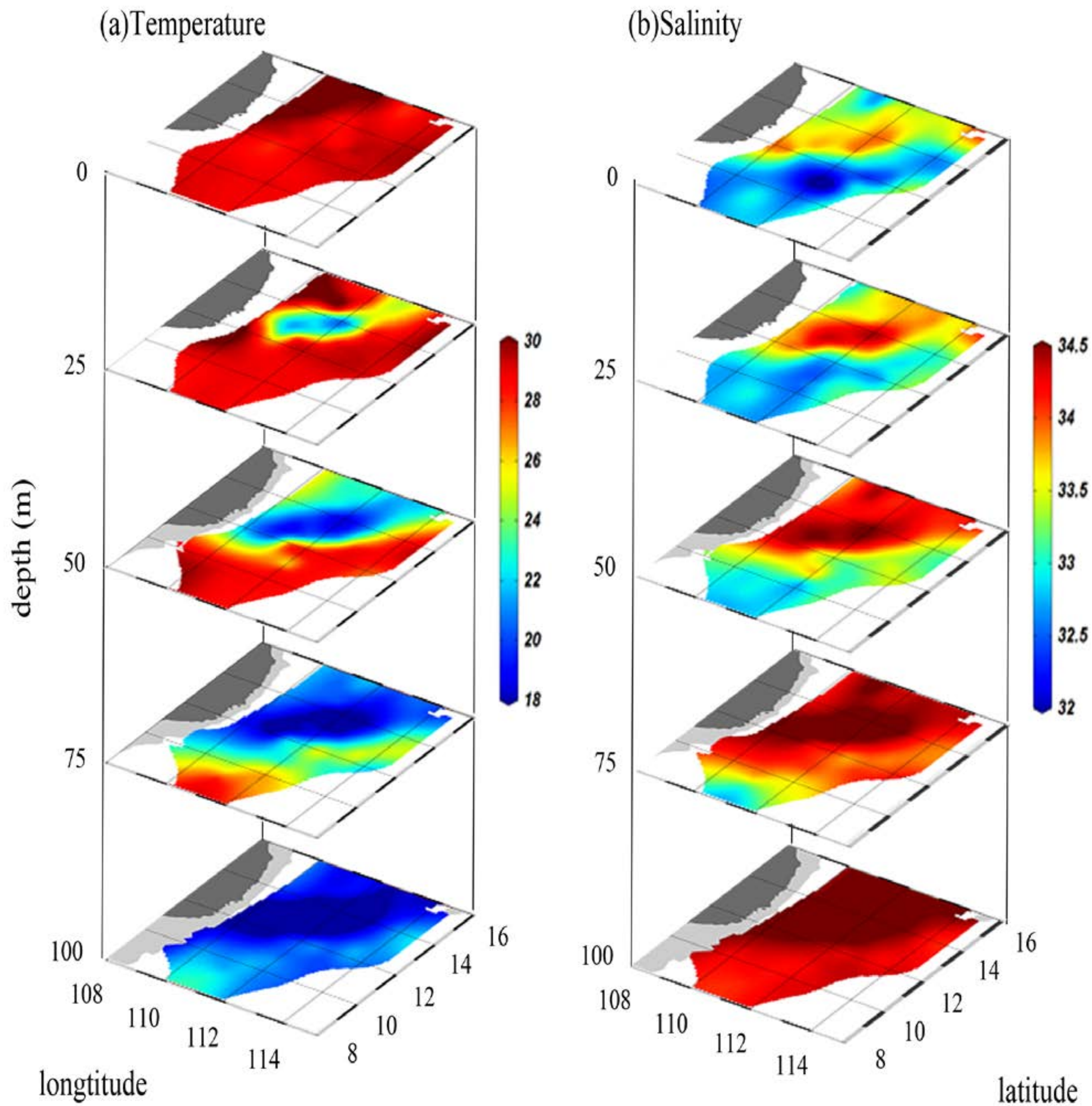
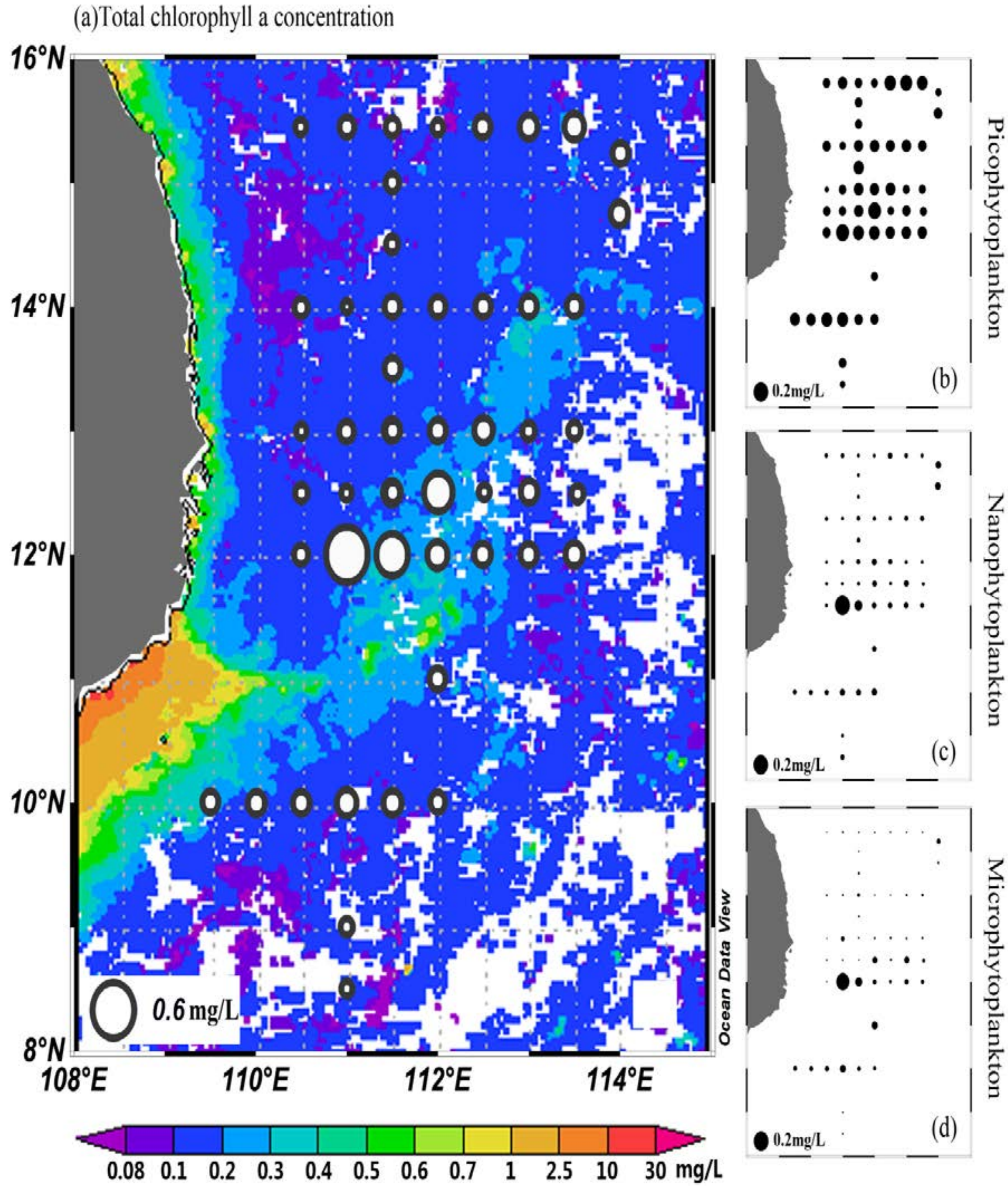


图6 叶绿素*a*浓度与（a）微微型浮游植物的比例；（b）微型浮游植物的比例；（c）小型浮游植物的比例的相关性。（d）温度与盐度的相关性。

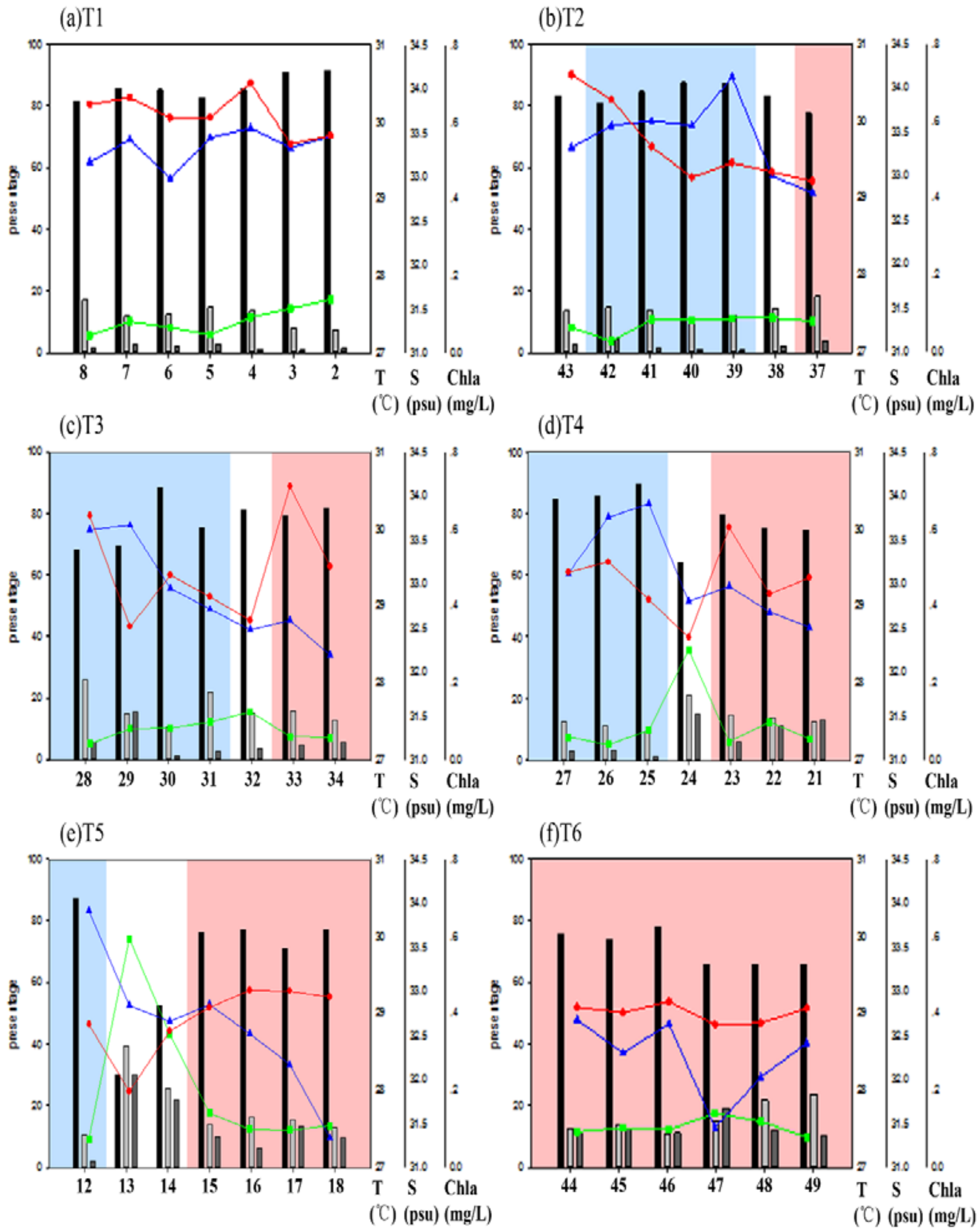
Fig.6 Correlation between in situ sea surface total chlorophyll a and percentage of (a) picophytoplankton, (b) nanophytoplankton and (c) microphytoplankton (d) Correlation between in situ surface temperature and salinity.



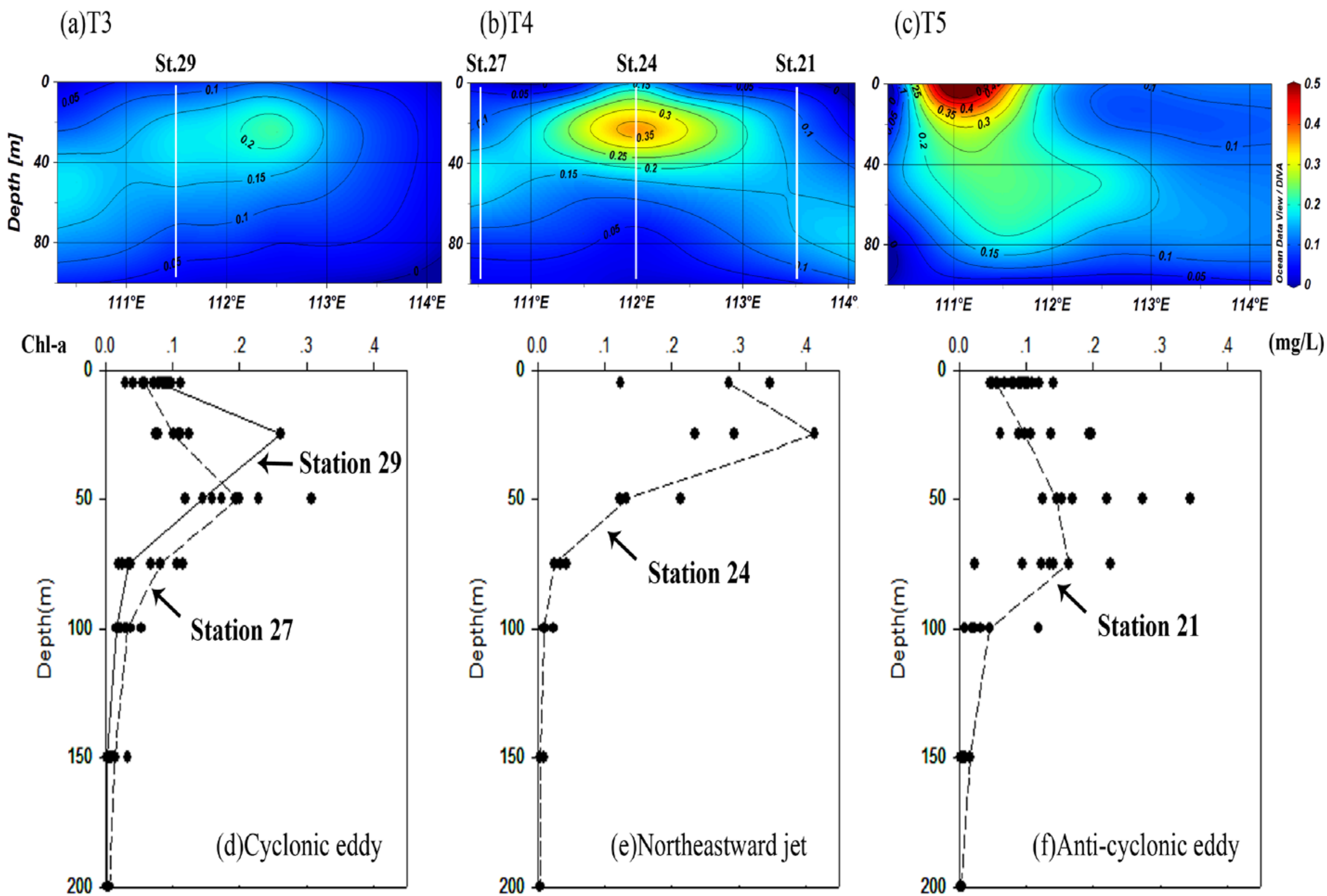
(a)Temperature
(b)Salinity
depth (m)
0
25
50
75
100
30
28
26
24
22
20
18
34.5
34
33.5
33
32.5
32
108
110
112
114
8
10
12
14
16
longtitude
latitude



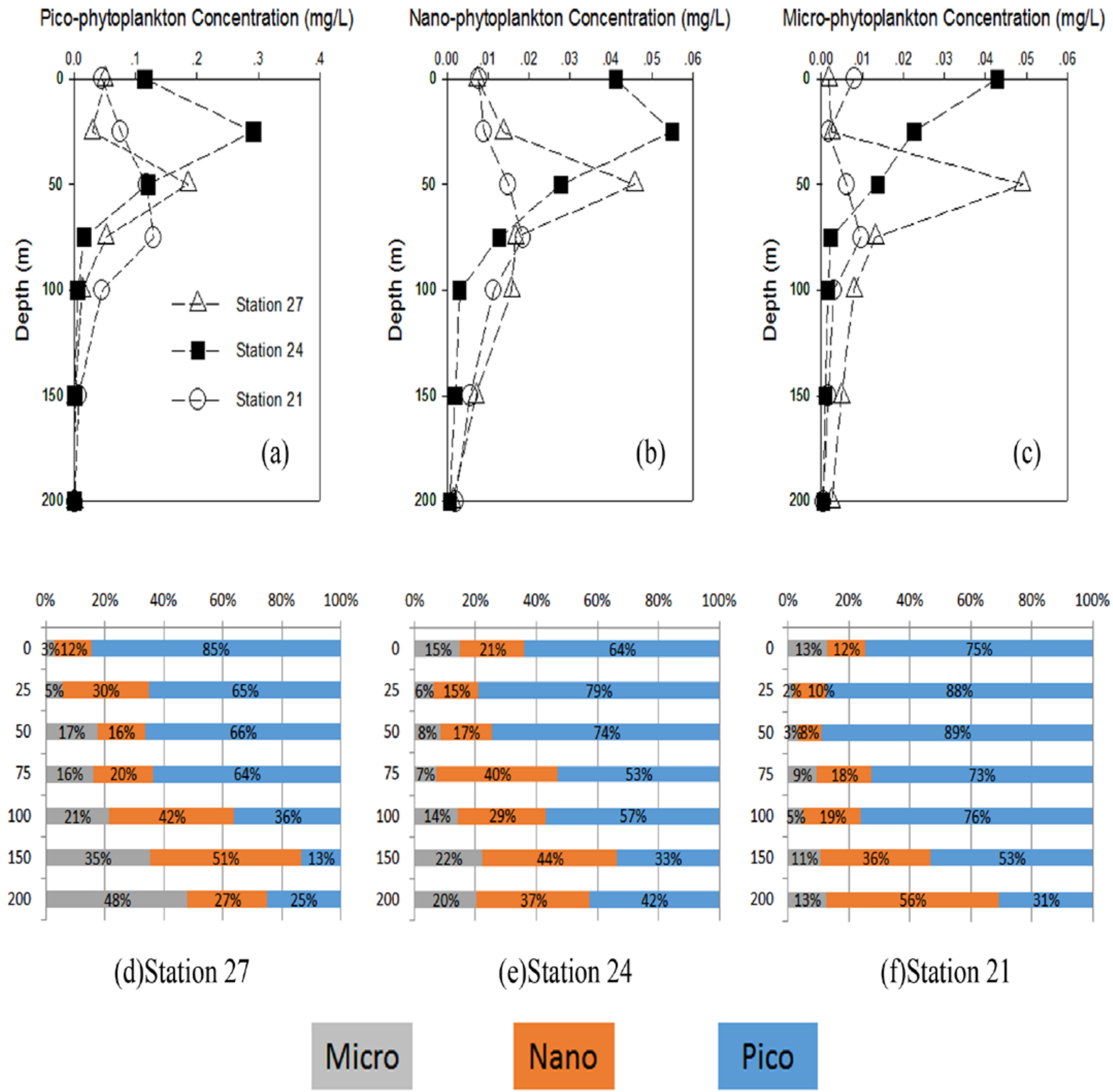
(a)Total chlorophyll a concentration
16°N
14°N
12°N
10°N
8°N
108°E
110°E
112°E
114°E
0.6 mg/L
Ocean Data View
0.08
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1
2.5
10
30
mg/L
0.2mg/L
(b)
Picophytoplankton
0.2mg/L
(c)
Nanophytoplankton
0.2mg/L
(d)
Microphytoplankton



(a)T1
8 7 6 5 4 3 2
T (℃) S (psu) Chla (mg/L)
(b)T2
43 42 41 40 39 38 37
T (℃) S (psu) Chla (mg/L)
(c)T3
28 29 30 31 32 33 34
T (℃) S (psu) Chla (mg/L)
(d)T4
27 26 25 24 23 22 21
T (℃) S (psu) Chla (mg/L)
(e)T5
12 13 14 15 16 17 18
T (℃) S (psu) Chla (mg/L)
(f)T6
44 45 46 47 48 49
T (℃) S (psu) Chla (mg/L)



(a)T3
(b)T4
(c)T5
St.29
St.27
St.24
St.21
Depth [m]
111°E
112°E
113°E
114°E
Ocean Data View / DIVA
Chl-a
(mg/L)
Depth(m)
Station 29
Station 27
Station 24
Station 21
(d)Cyclonic eddy
(e)Northeastward jet
(f)Anti-cyclonic eddy



Pico-phytoplankton Concentration (mg/L)
Nano-phytoplankton Concentration (mg/L)
Micro-phytoplankton Concentration (mg/L)
Depth (m)
Station 27
Station 24
Station 21
(a)
(b)
(c)
(d)Station 27
(e)Station 24
(f)Station 21
Micro
Nano
Pico

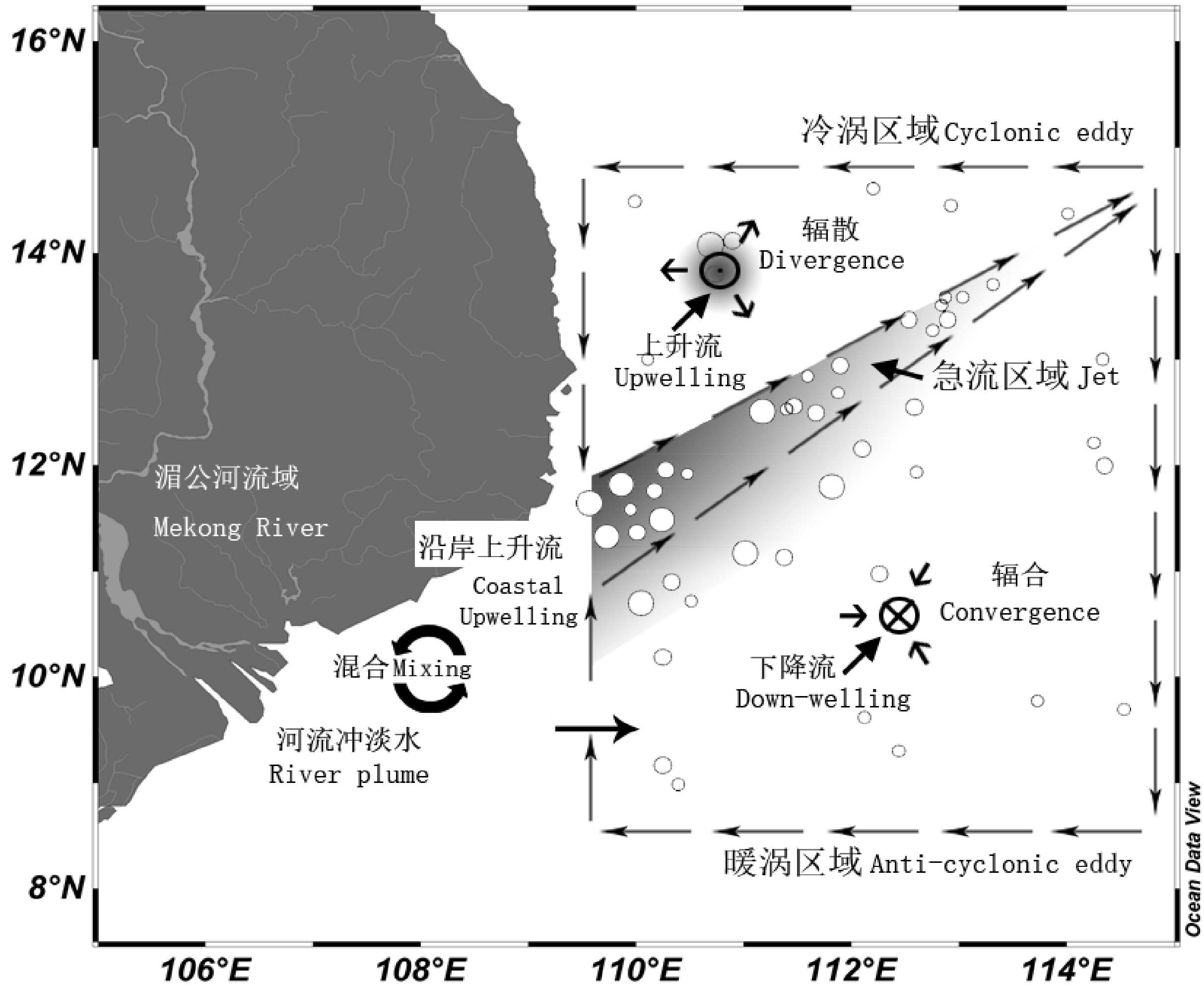
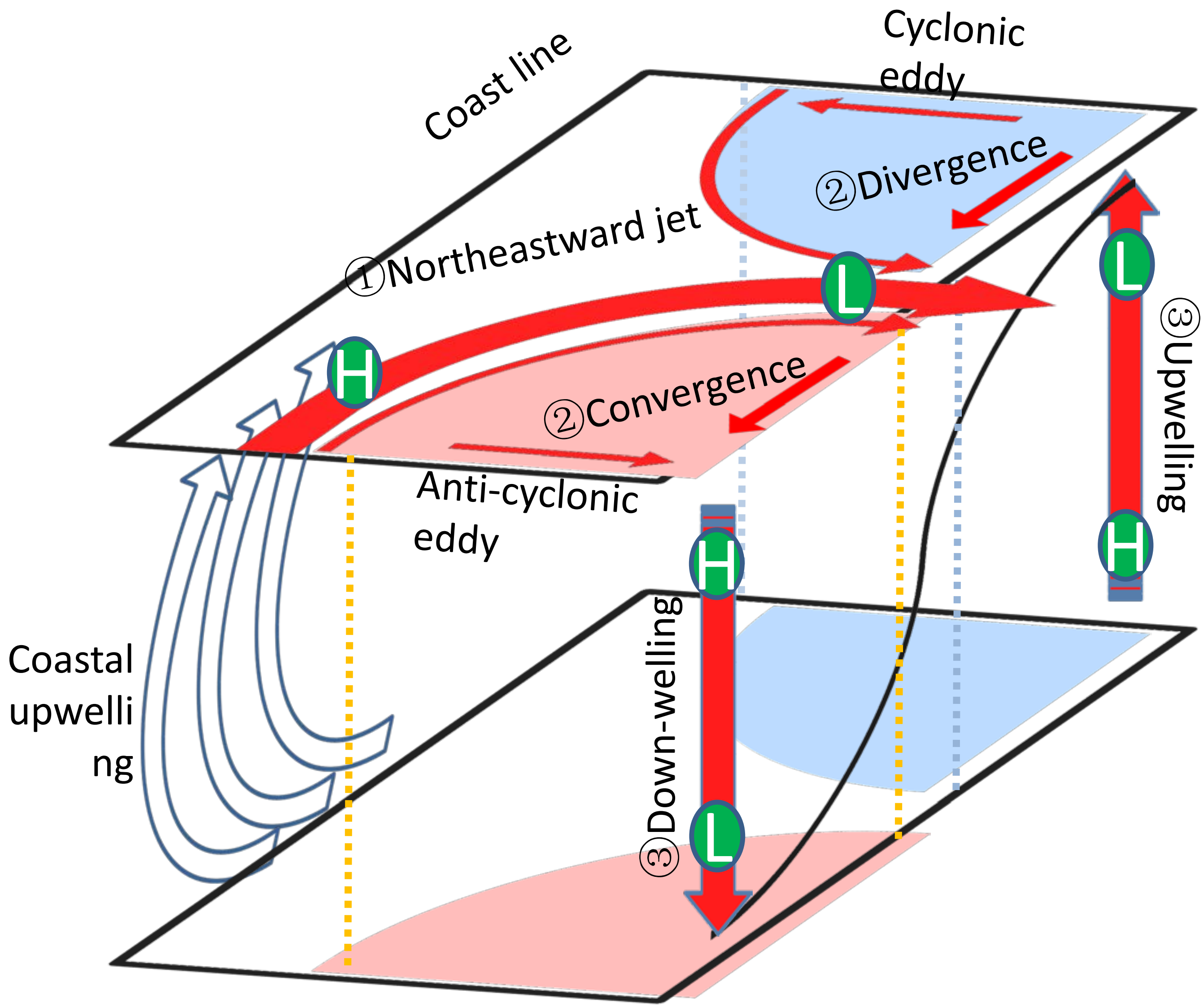
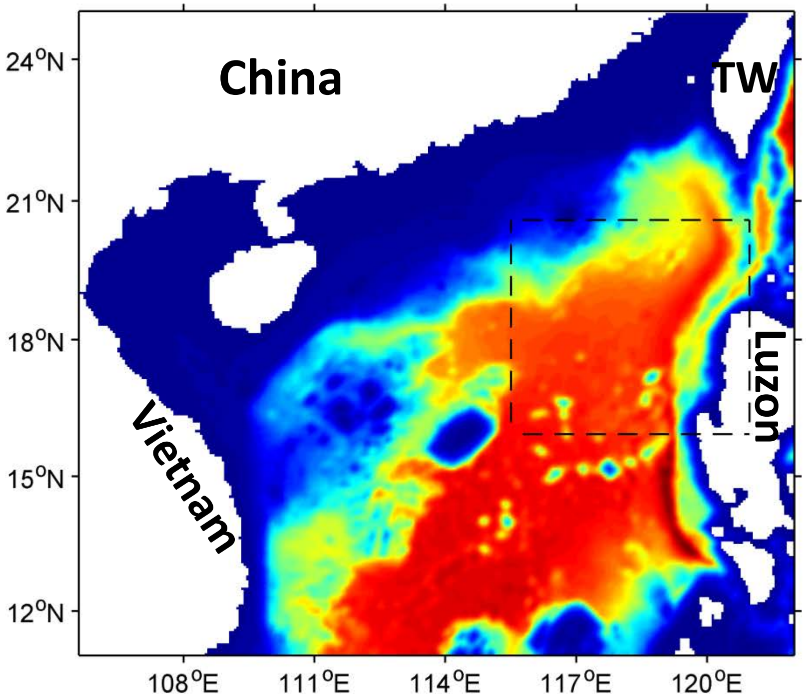


Fig.7 Conceptual sea surface size structure characteristics of phytoplankton and its influence mechanism in summertime western South China Sea.

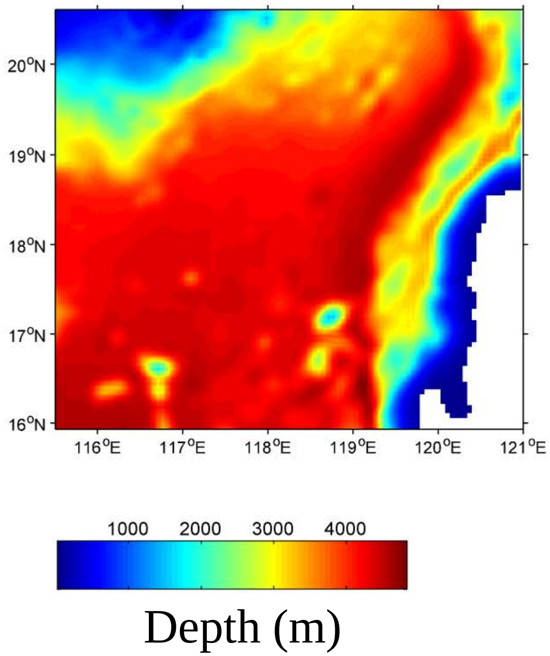

Coast line
Cyclonic
eddy
②Divergence
①Northeastward jet
L
H
②Convergence
Anti-cyclonic
eddy
H
L
③Upwelling
Coastal
upwelli
ng
H
③Down-welling
L

Nested-grid ocean circulation model (ROMS)

Level-1 Model



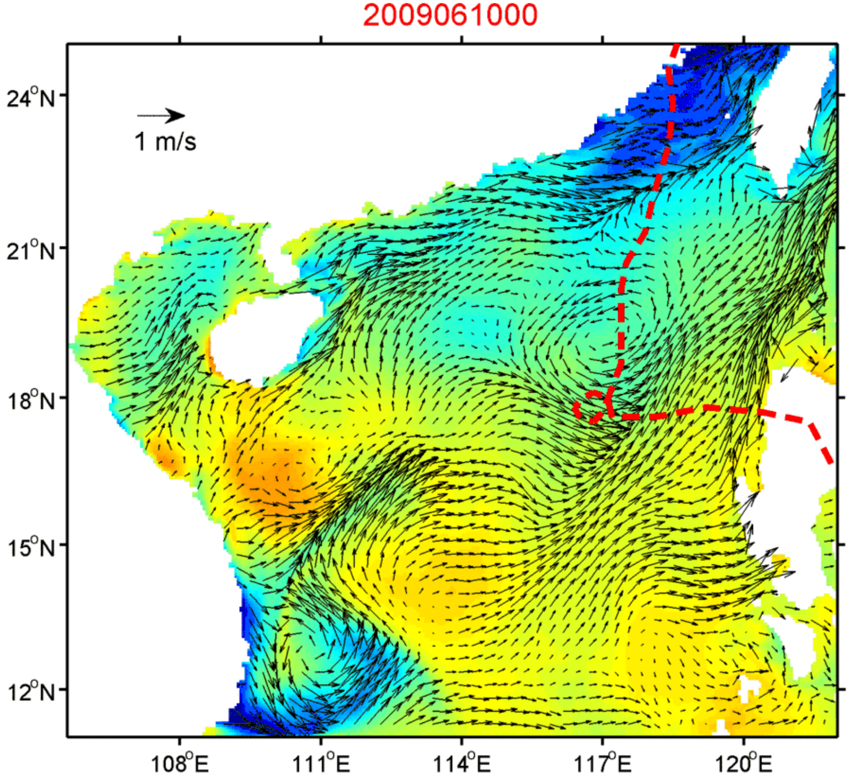
Level-2 Model



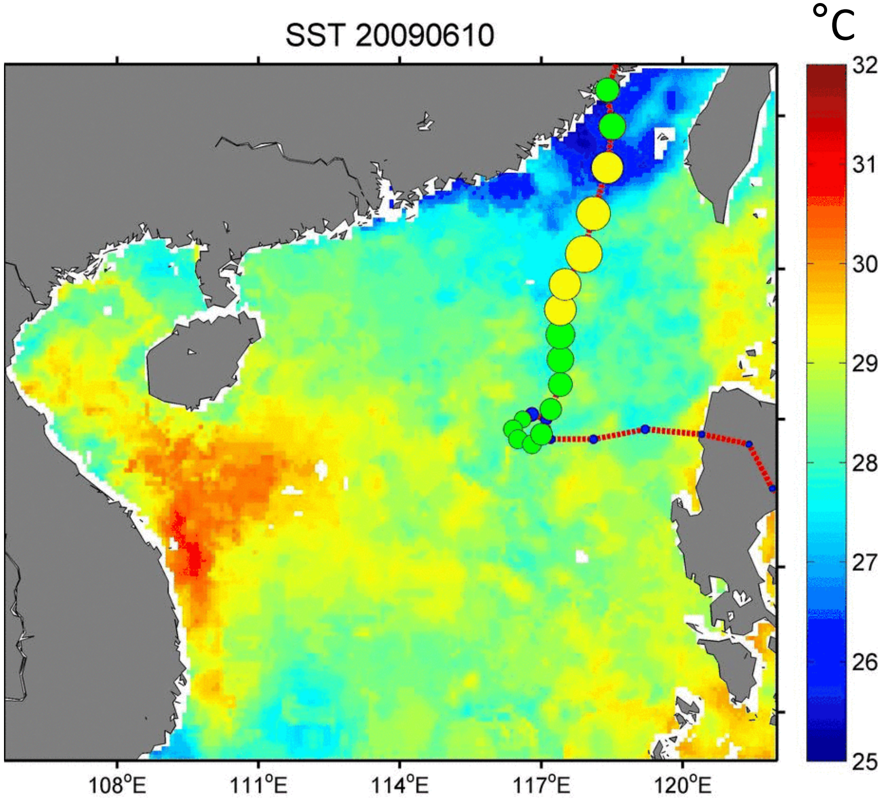
Horizontal grid size 1/18° (~ 6 km)	Horizontal grid size 1/54 ° (~ 2 km)
40 sigma levels	40 sigma levels
Boundary condition: SODA	
Topography data: GEBCO	
The surface forcing: CFSR (0.3°)+parametric vortex	

The SST comparison between model and remote sensing data

Model



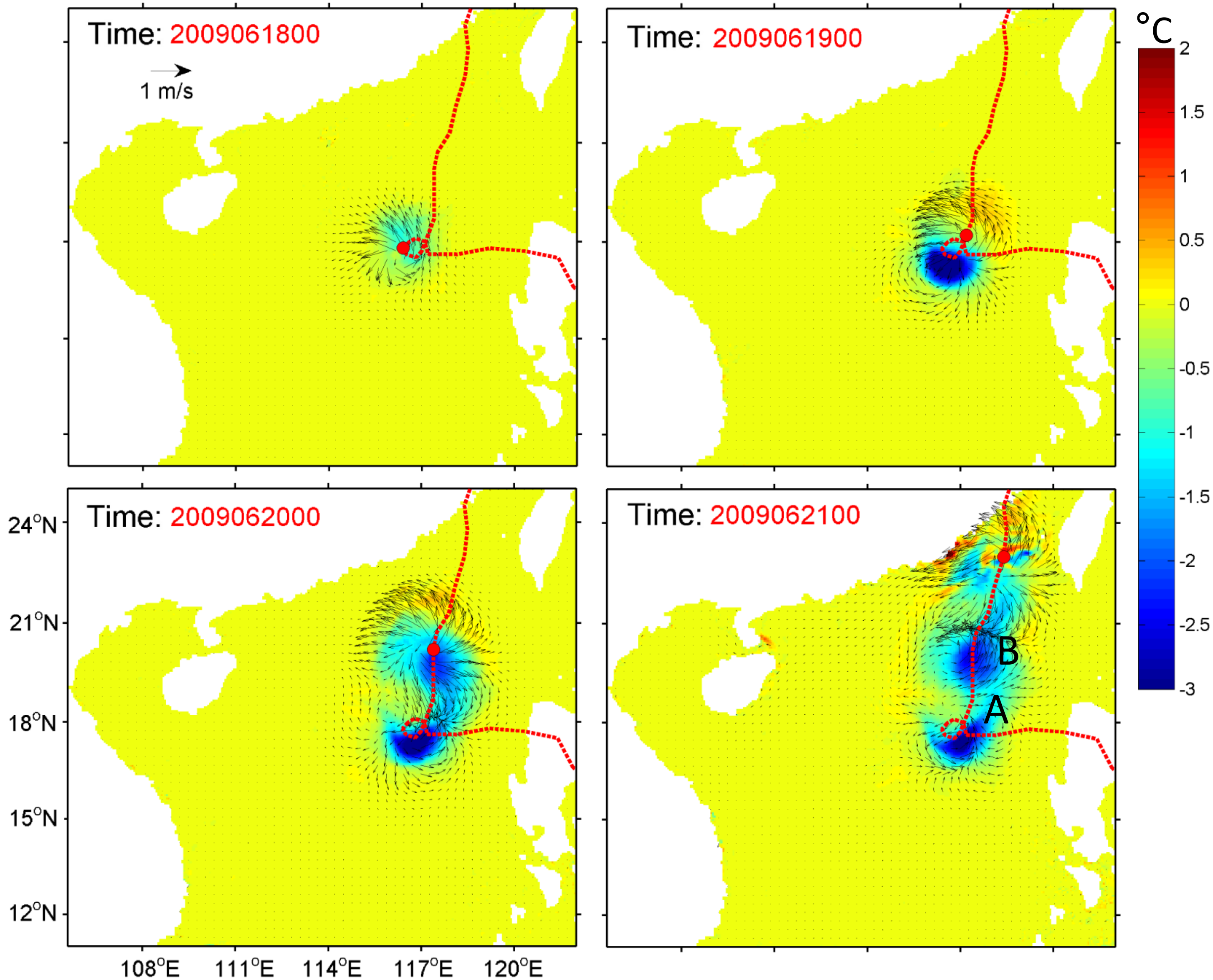
Remote sensing data



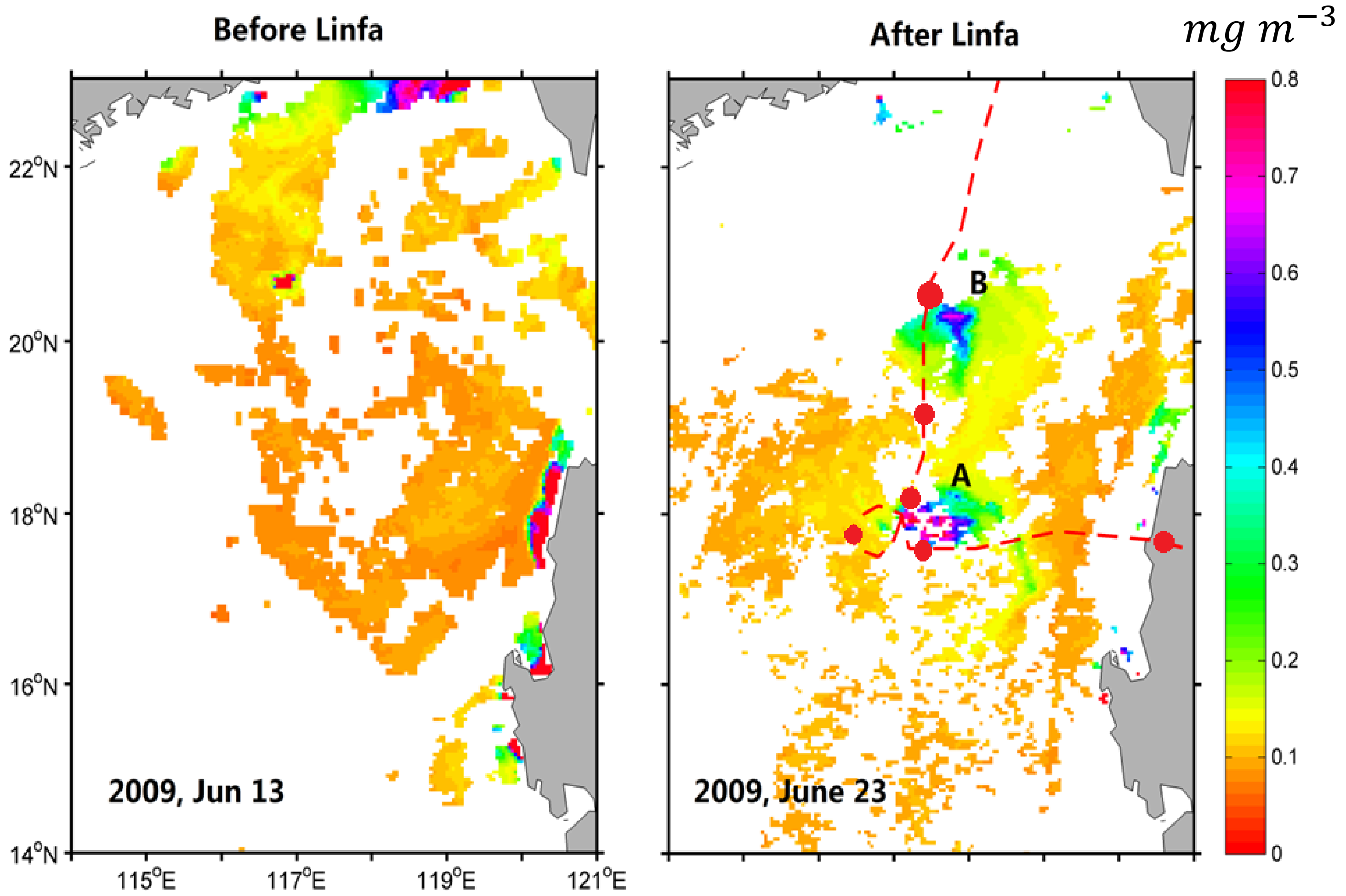
GHRSST L4 OSTI data (~ 5 km)

Storm-induced surface circulation and SST change

(Vortex Run – Smoothed Run)

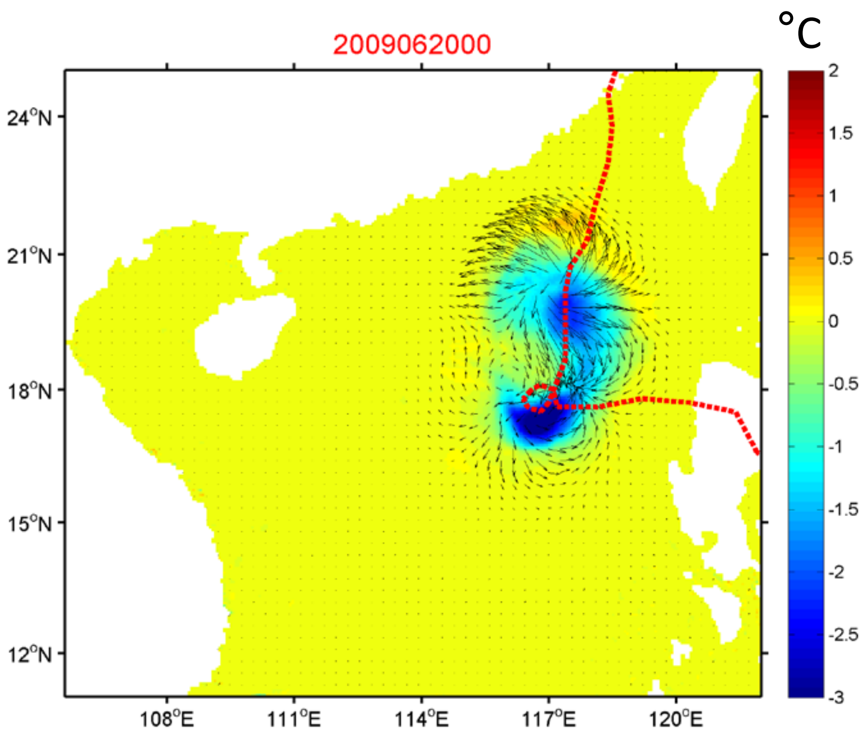


MODIS surface chl-a concentration



MODIS-derived sea surface chl-a concentration. (a) Before cyclone Linfa and (b) after cyclone Linfa. The red dashed line represents the storm track.

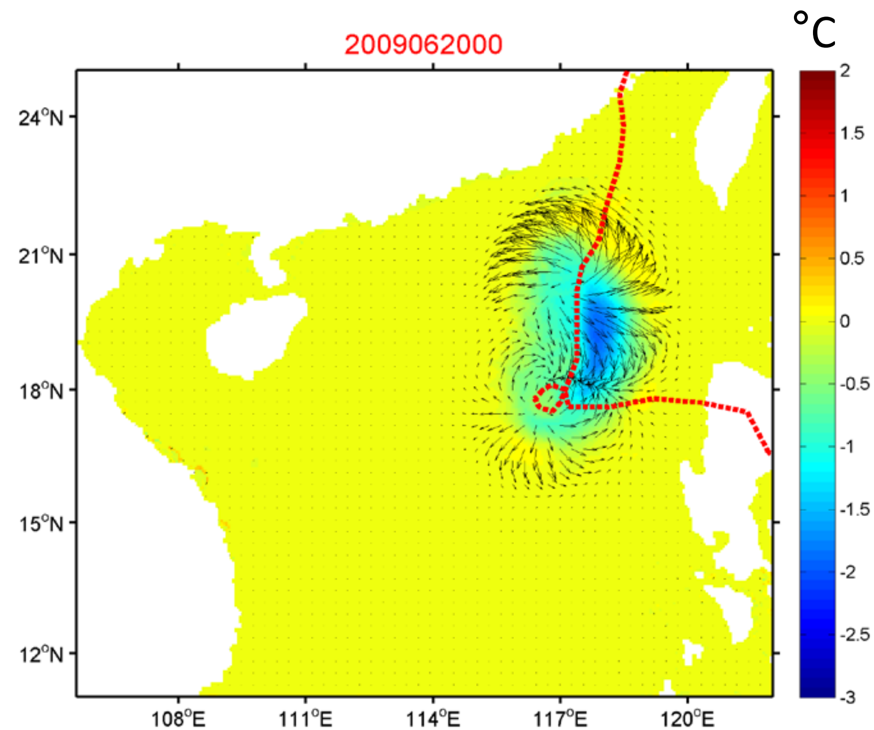
Vortex Run – Smoothed Run



The typhoon induced ocean response due to **upwelling + vertical mixing**

Vortex NoAdv Run - Smoothed NoAdv Run

The advection terms in the model tracer equations are switched off



The typhoon induced ocean response due to **vertical mixing**

- How important
- Ocean color ??

Milestone

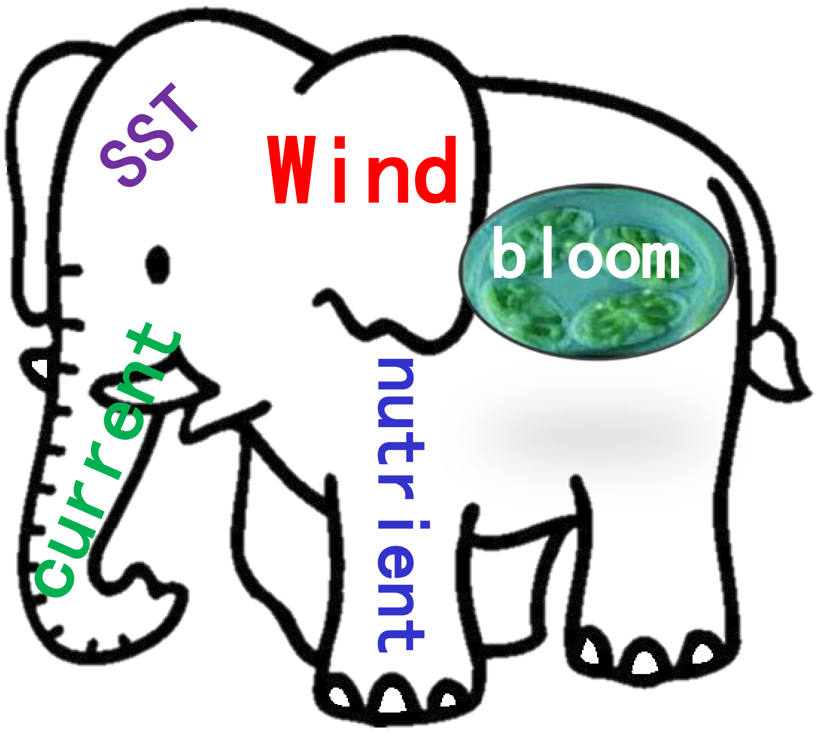
- Satellite remote sensing, in Ocean Sciences
- Ocean color- Marine Biology marine Ecology

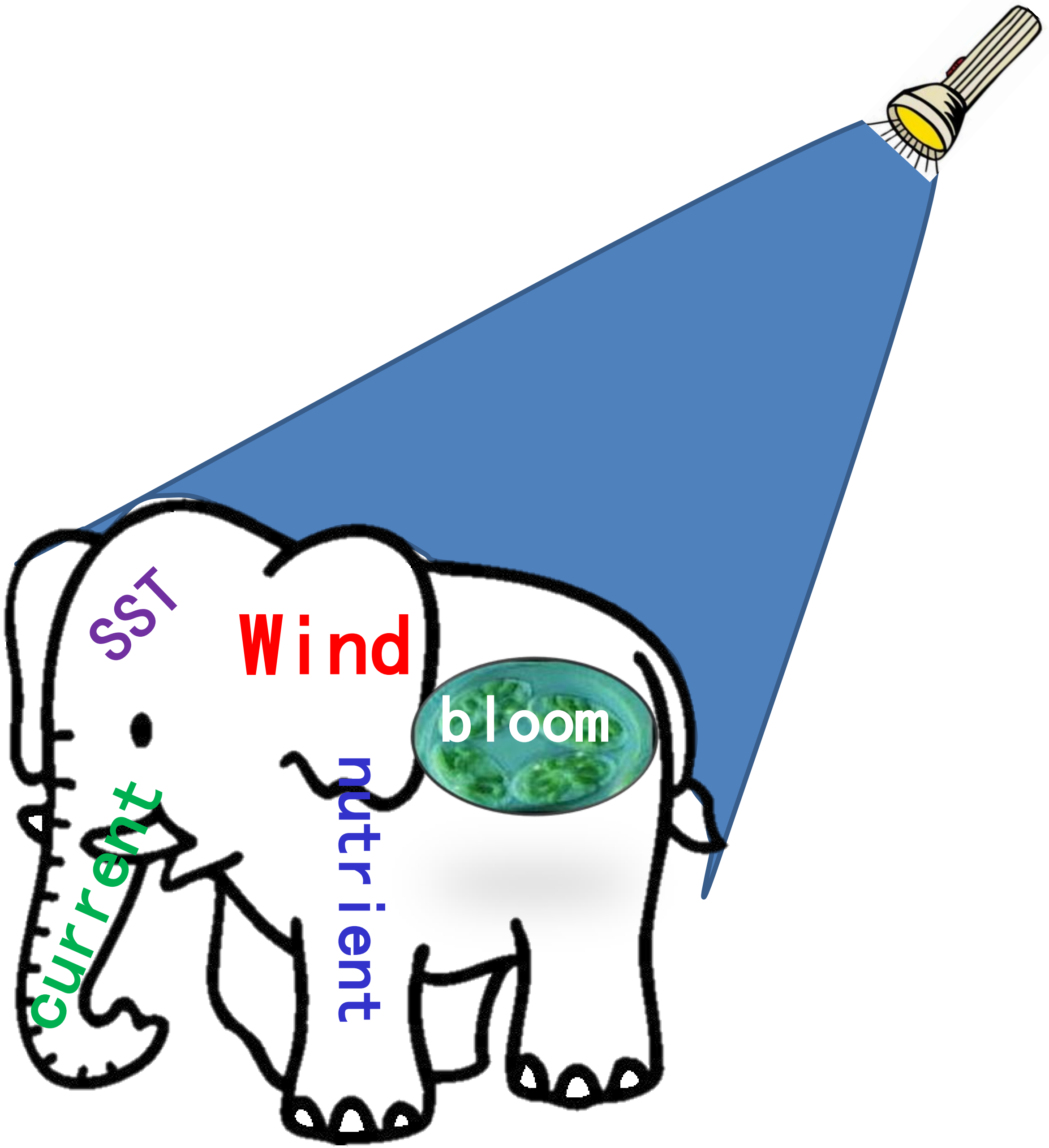
Ocean Color remote sensing –Chl-a – relate marine biology –。

- Multi –
- channel
- Sensors
- Satellite
- Access
- ….people

Milestone

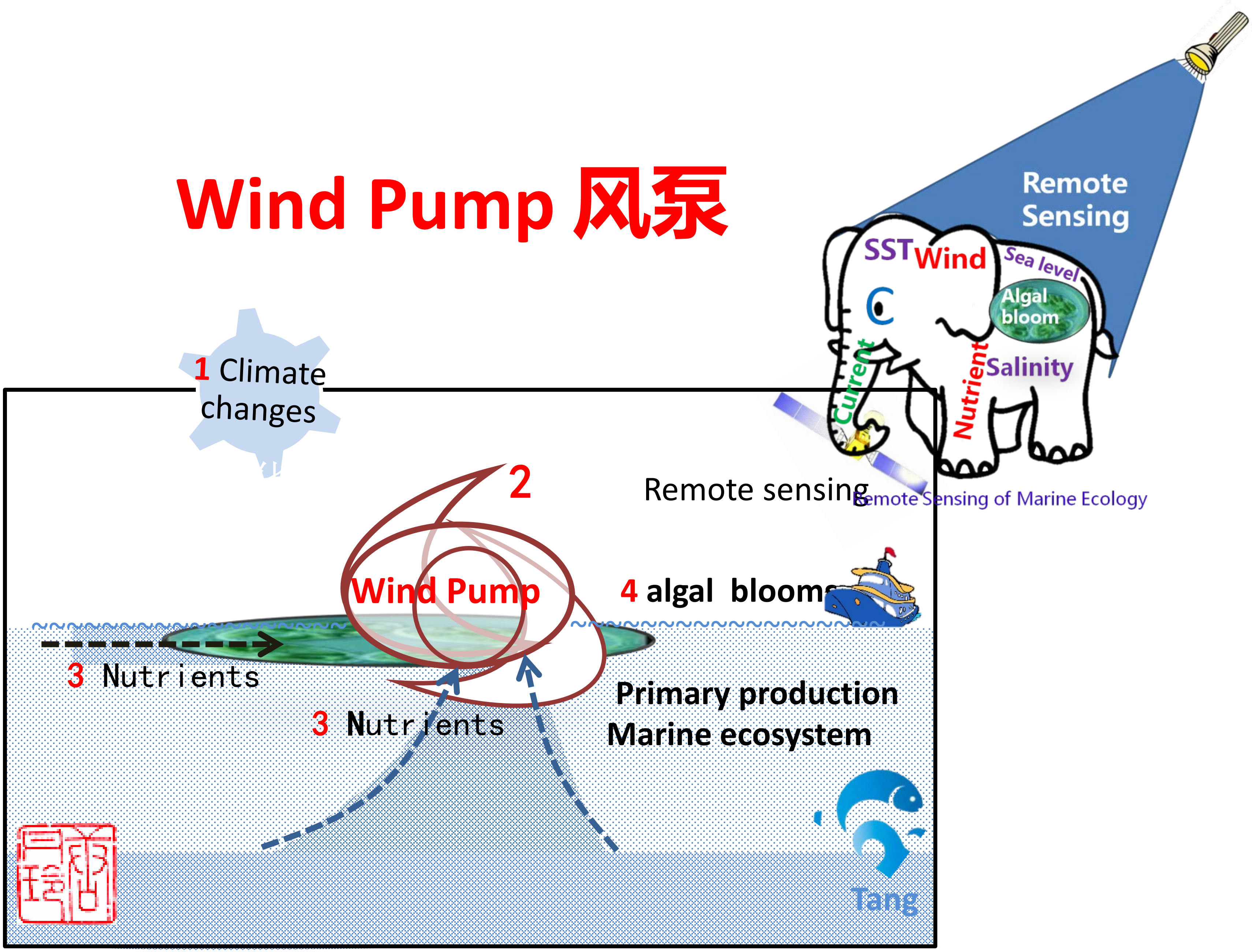
“Remote sensing of Marine Ecology


SST
Wind
bloom
current
nutrient



SST
Wind
bloom
current
nutrient

Wind Pump 风泵



Remote Sensing
SST
Wind
Sea level
Algal bloom
C
Current
Nutrient
Salinity
Remote Sensing of Marine Ecology
1 Climate changes
2
Remote sensing
Wind Pump
4 algal blooms
3 Nutrients
3 Nutrients
Primary production
Marine ecosystem
Tang

DanLing TANG (lingzis)

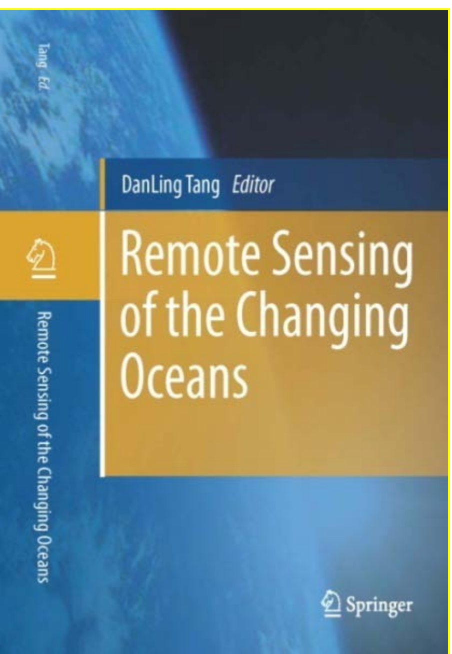
Thank You!

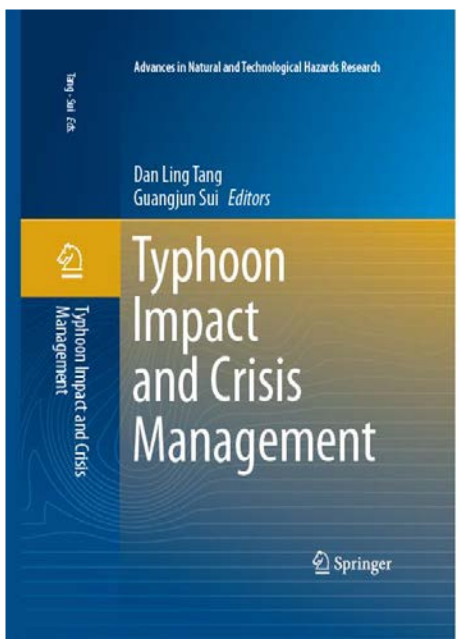
South China Sea Institute of Oceanology

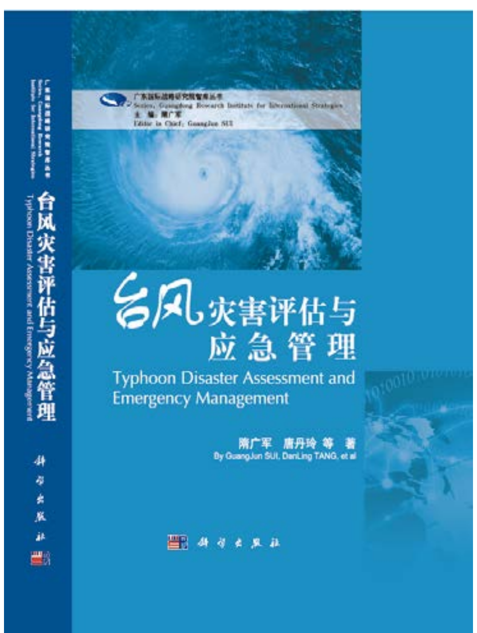
Chinese Academy of Sciences

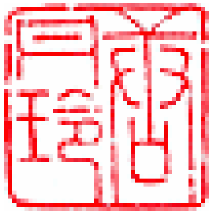
lingzistdl@126.com, 13924282728

Springer
the language of science



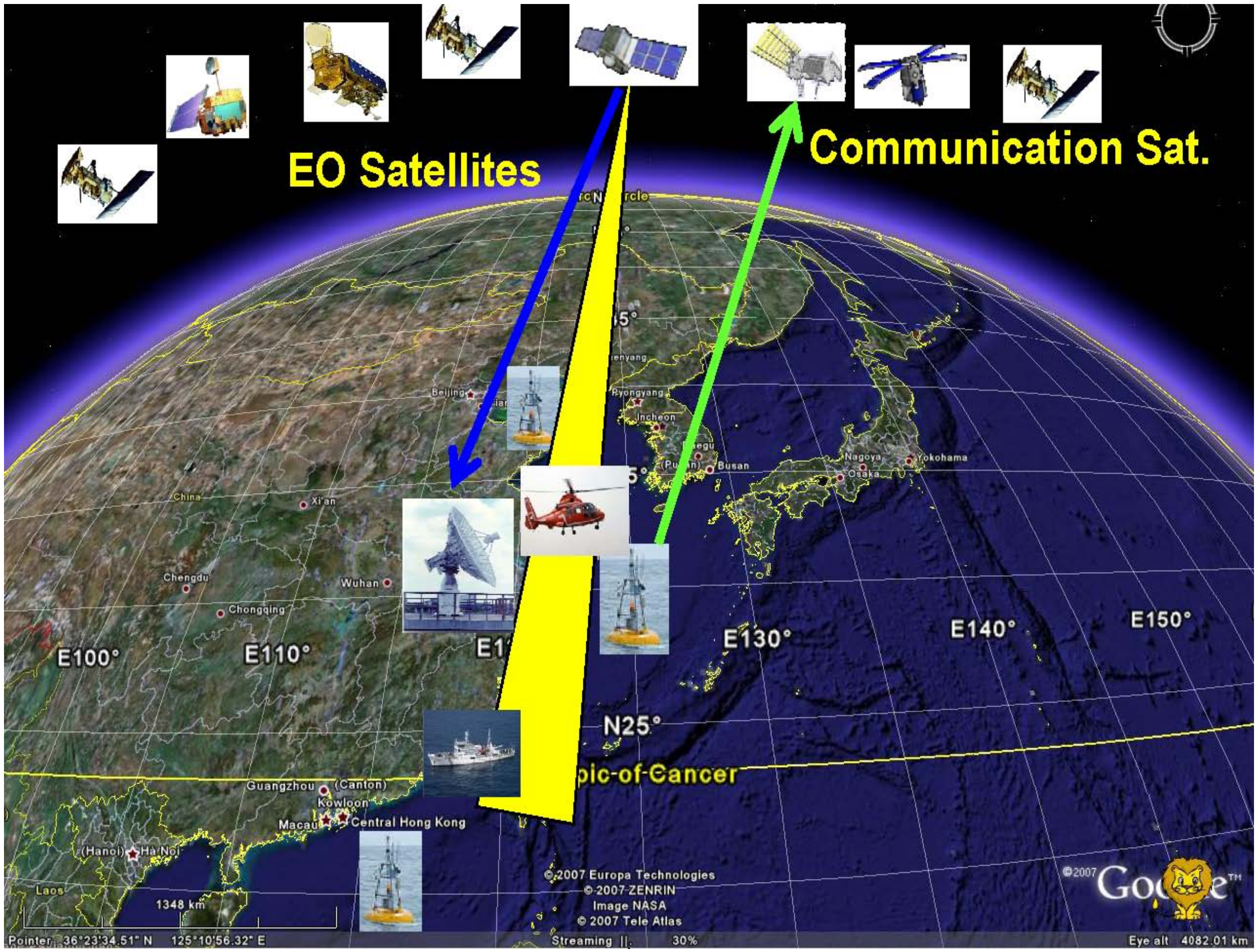






- 1,
- 2,
- 3. Wind pump

Satellite Remote Sensing



遥感----远离地球，利用物体的光谱特征获取其空间信息，从而认识物体空间属性的技术。

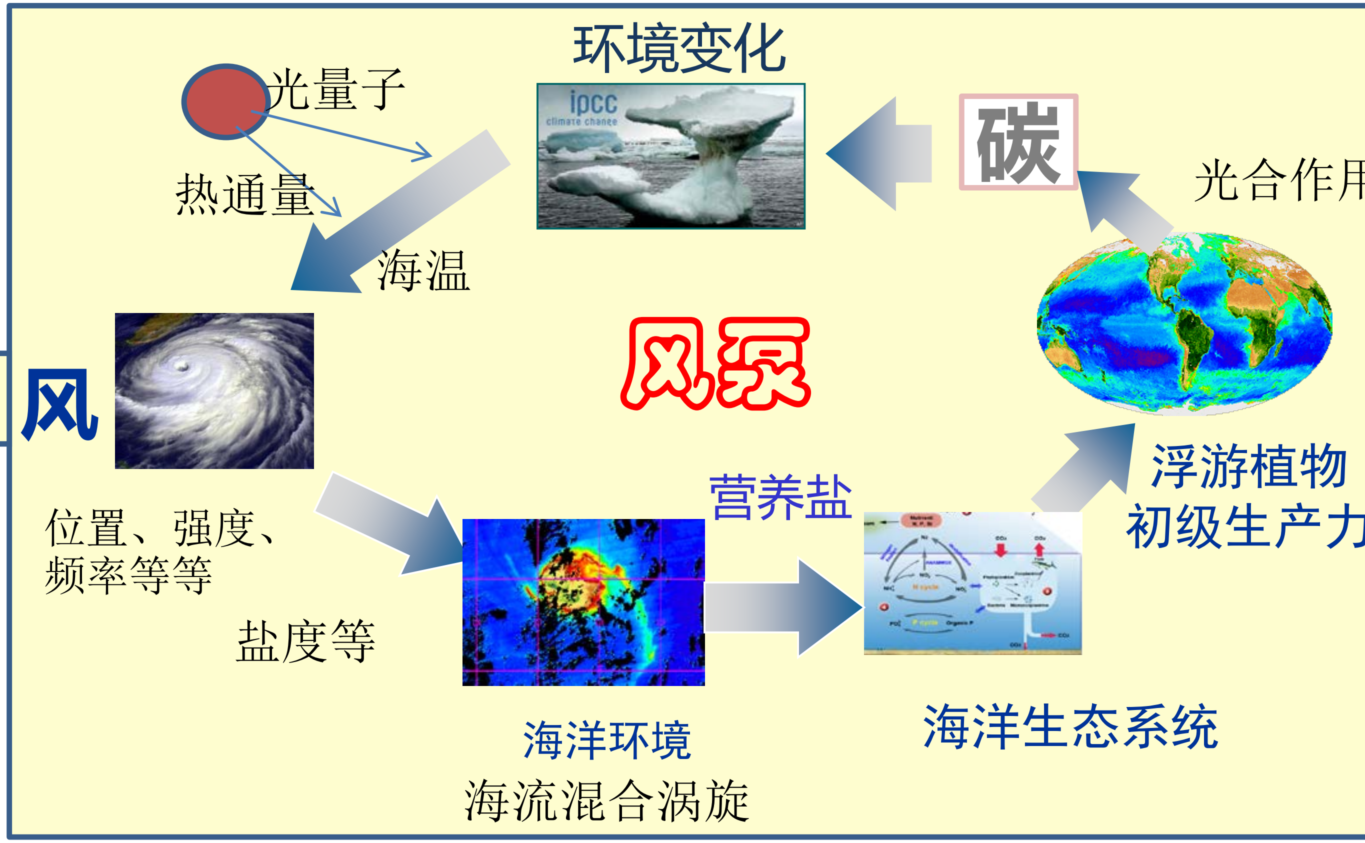
- Multi –
- channel
- Sensors
- Satellite
- Access
- ….people

Pan Ocean Remote Sensing

"风泵" 前瞻性基础理论

风作用于海洋表面，改变水体的移动，并产生一系列环境生态效应，这一过程统称为"风泵"。

台风灾害环境



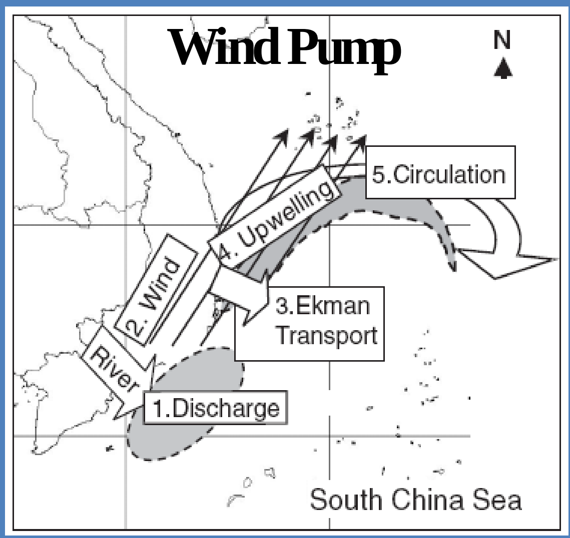
渔业资源

"风泵"改变营养盐输运，促进海洋生源要素循环，驱动上层海洋初级生产以及生态系统，并进一步影响海洋固碳过程及全球渔业资源。

“风泵”理论的发展

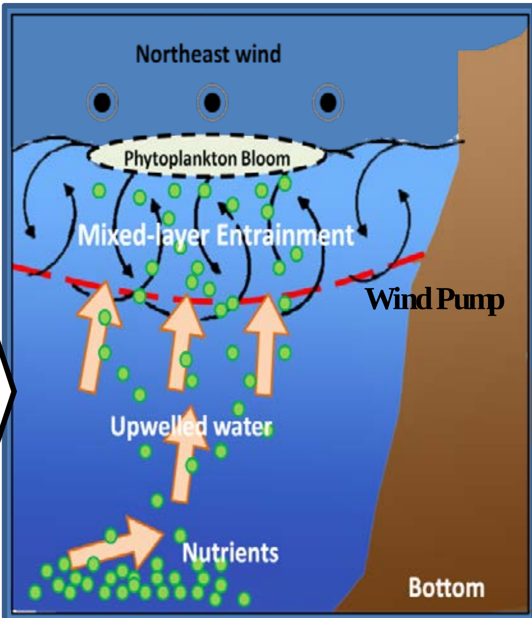
发展阶段

“风泵Wind Pump”理论的发展



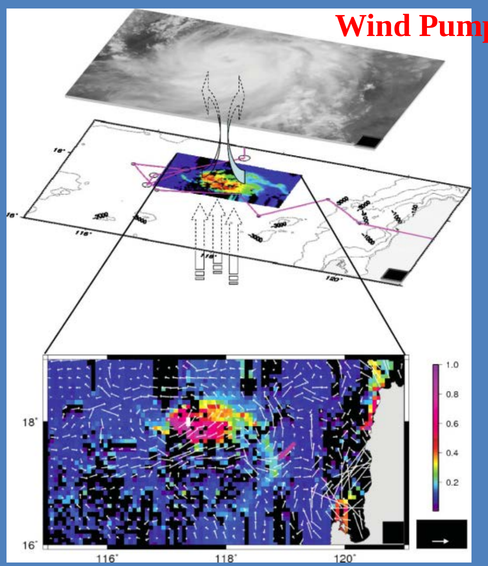
2004

强风--海洋浮游植物藻华



2010

季风--海洋生态



2015

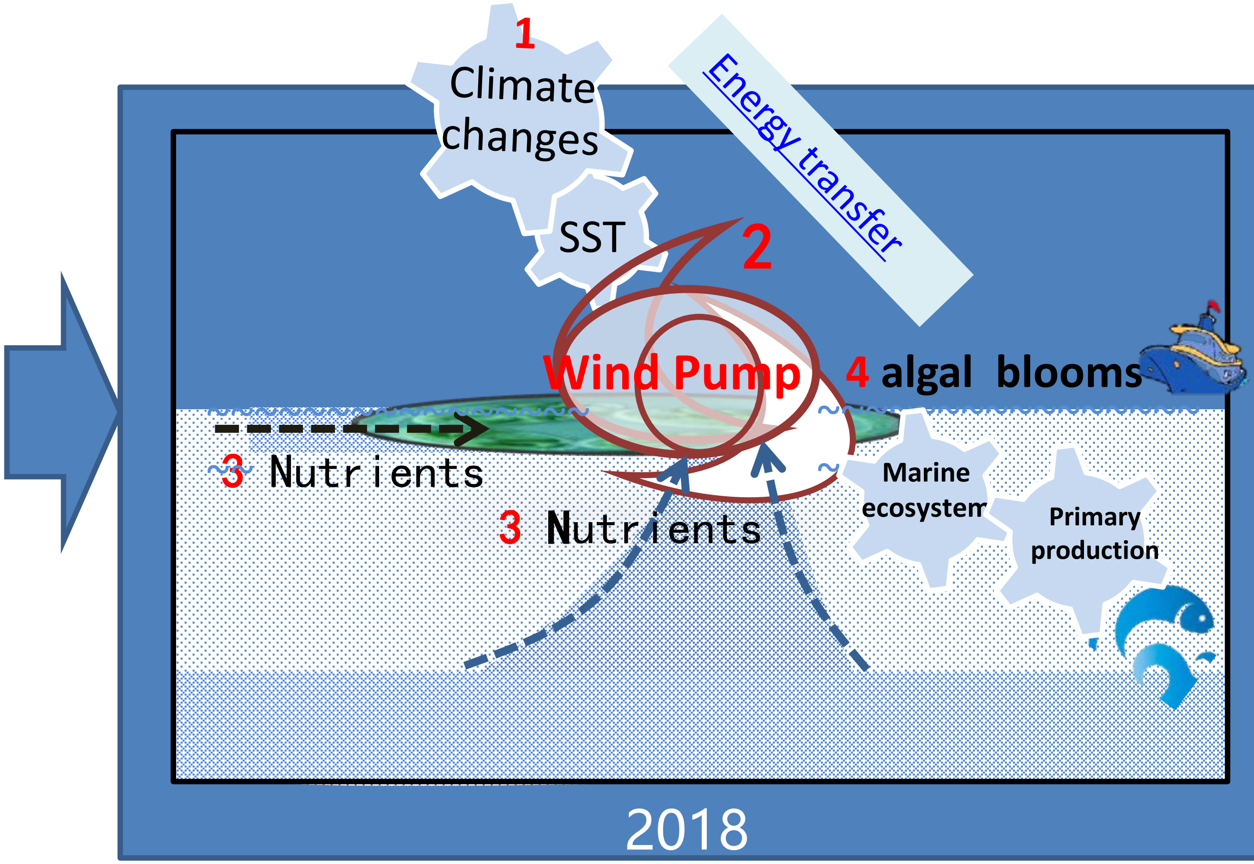
台风--海洋动力环境

?

（ Wind pump 也是海洋藻华动力假设的第3个理论）

“风泵” 研究发展趋势

现阶段

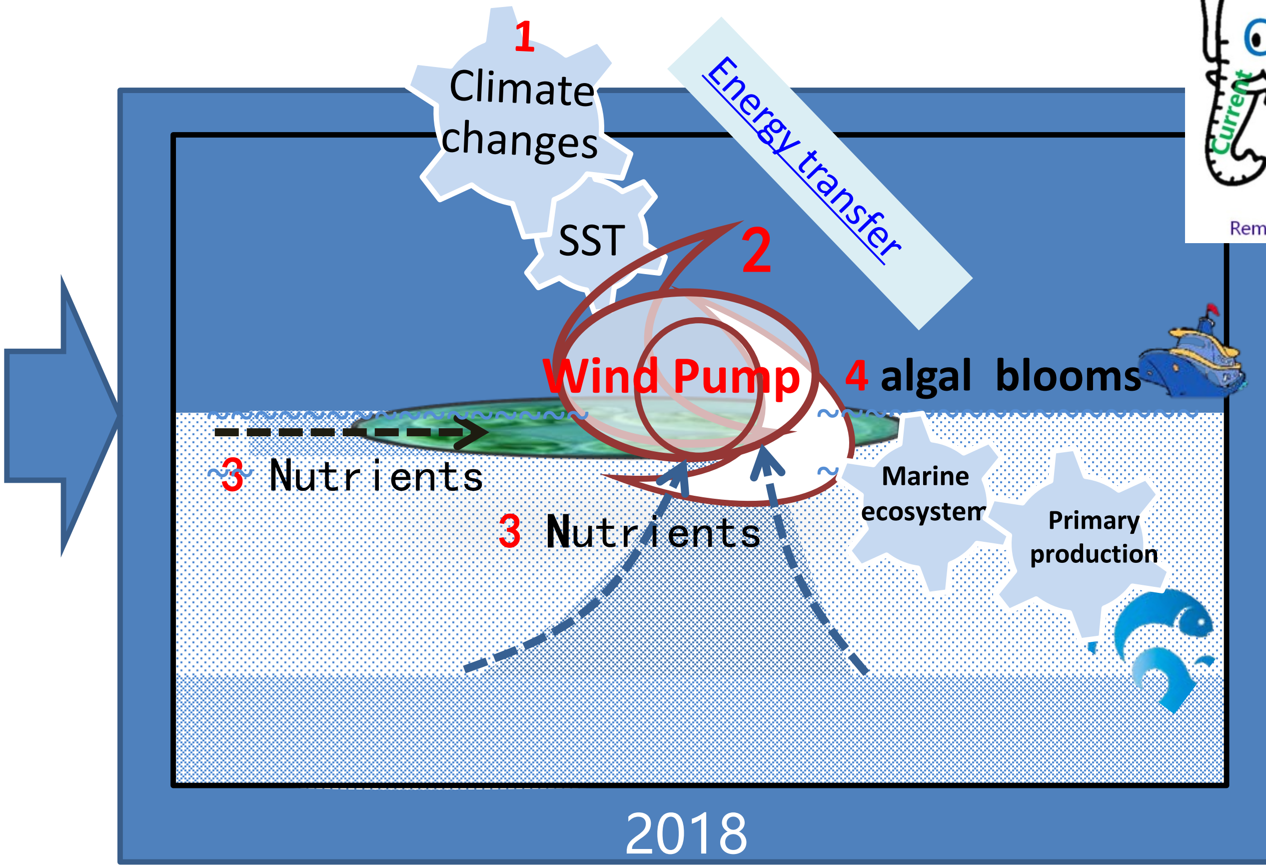


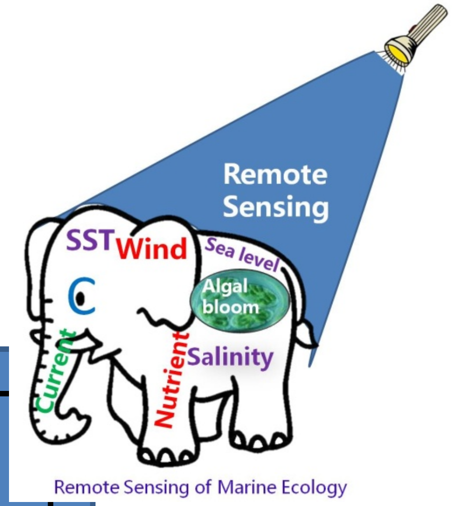
从能量传递角度，

突破传统研究学科局限性，开放系统构架下的“风泵” 研究

“风泵” 研究发展趋势

现阶段





从能量传递角度，

突破传统研究学科局限性，开放系统构架下的“风泵” 研究

总结

海洋藻华形成 3 个经典理论

营养、温度、光

1. “临界深度理论”
critical depth hypothesis

1935 - 1953

混合层深度 < 临界深度

海洋物理

在养盐对浮游植物的生长无限制作用海区

2. “富营养化”
Eutrophication

1971-1975

人类活动相关
富营养化

近岸藻华

3. “风泵理论”
Wind Pump

2004-2017

全球环境变化
能量传递
卫星遥感

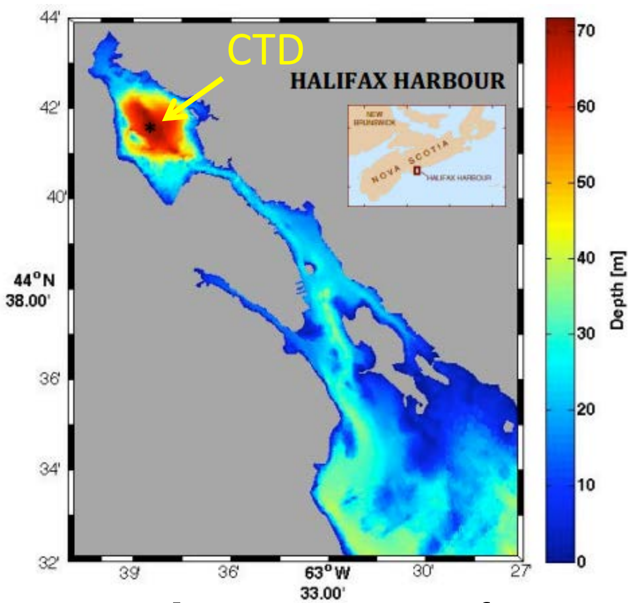
开放架构 海洋

主要解释藻华	●由局地形成 ●时间位置较为固定 ●持续时间较长	●非局地形成 ●时间位置不固定 ●持续时间较短

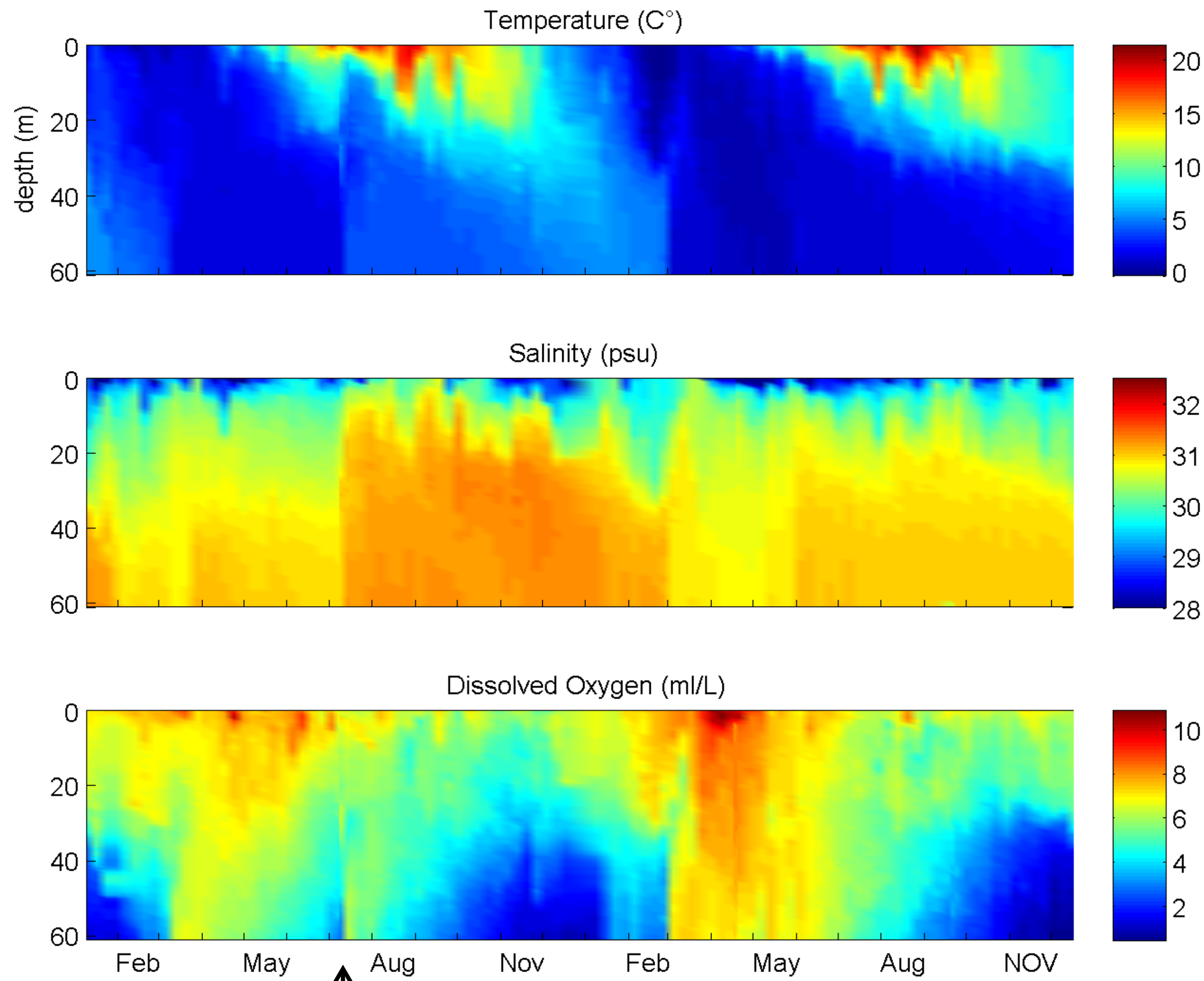
Outline

- Introduction
  - General Circulation over eastern Canadian shelf (ECS)
- Objective
  - To examine the circulation, dispersion, retention, and hydrodynamic connectivity of surface waters over the ECS
  - To understand the physical processes that characterize the upper ocean response to tropical cyclones
  - To study the dynamic of the storm-induced deep water intrusion of Halifax Harbour
- Preliminary Results

Observations in Bedford Basin (2014 - 2015)



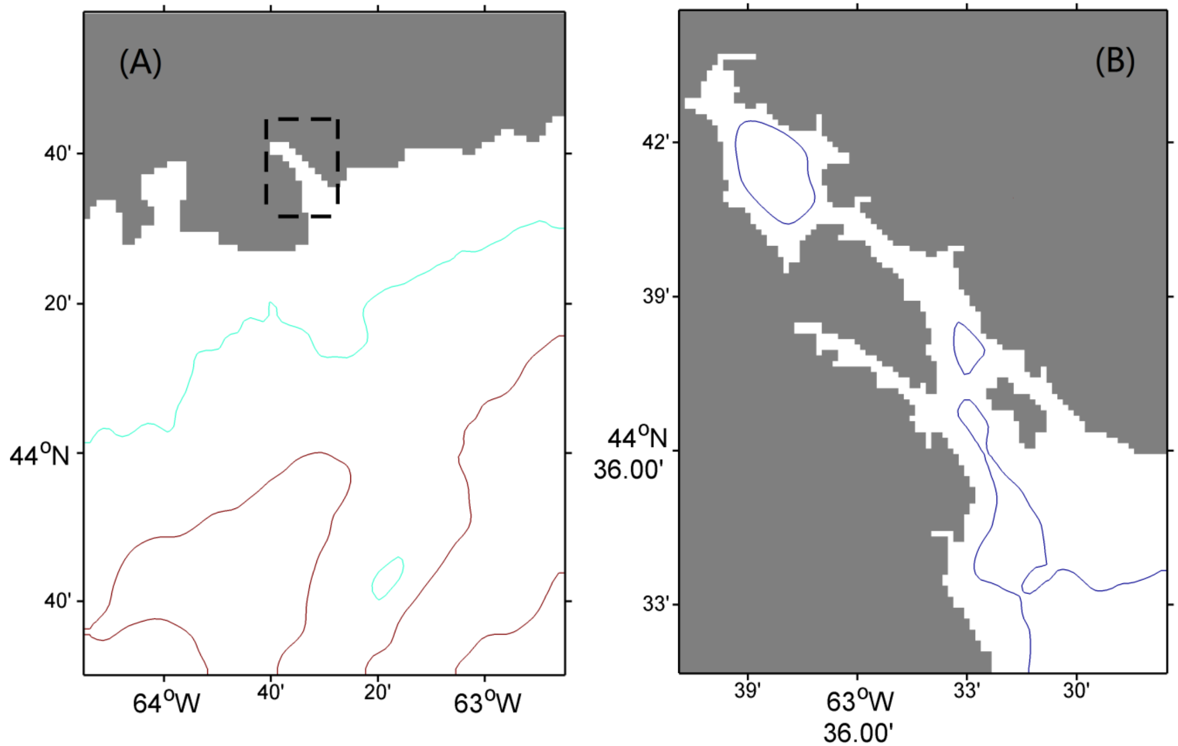
Bathymetric map of
Halifax Harbour
(W. J. Burt et. al 2013)



Hurricane Arthur

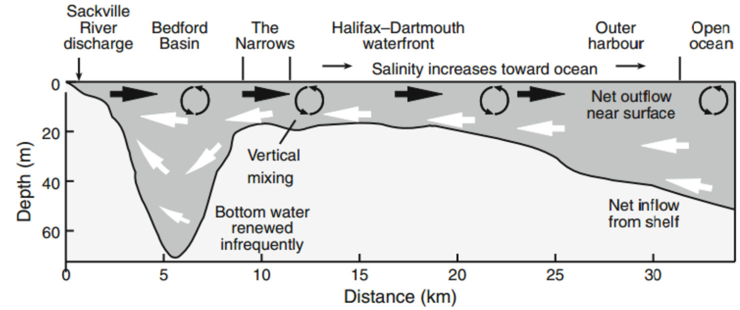
Nested-grid ocean circulation model (ROMS)

Level-1 Model **Level-2 Model**

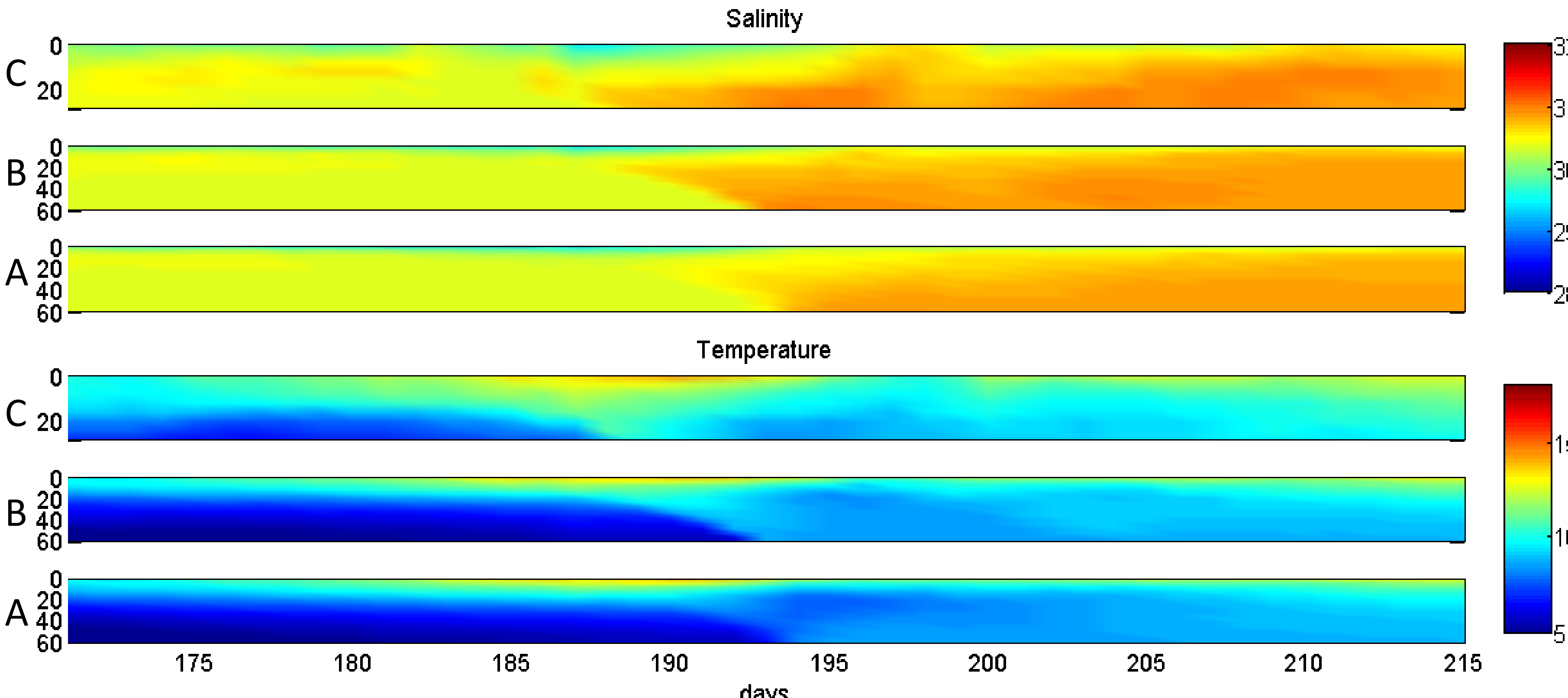


Horizontal grid size 1/50°	Horizontal grid size 1/400 (~ 270 m)
32 sigma levels	32 sigma levels
Boundary condition: SODA	River runoff : Bulkley and Winters (1992)
GEBCO	Water depth data provided by David Greenberg at BIO + GEBCO
The surface forcing: CFSR	
The tidal forcing: Oregon State University global model TPXO.7	

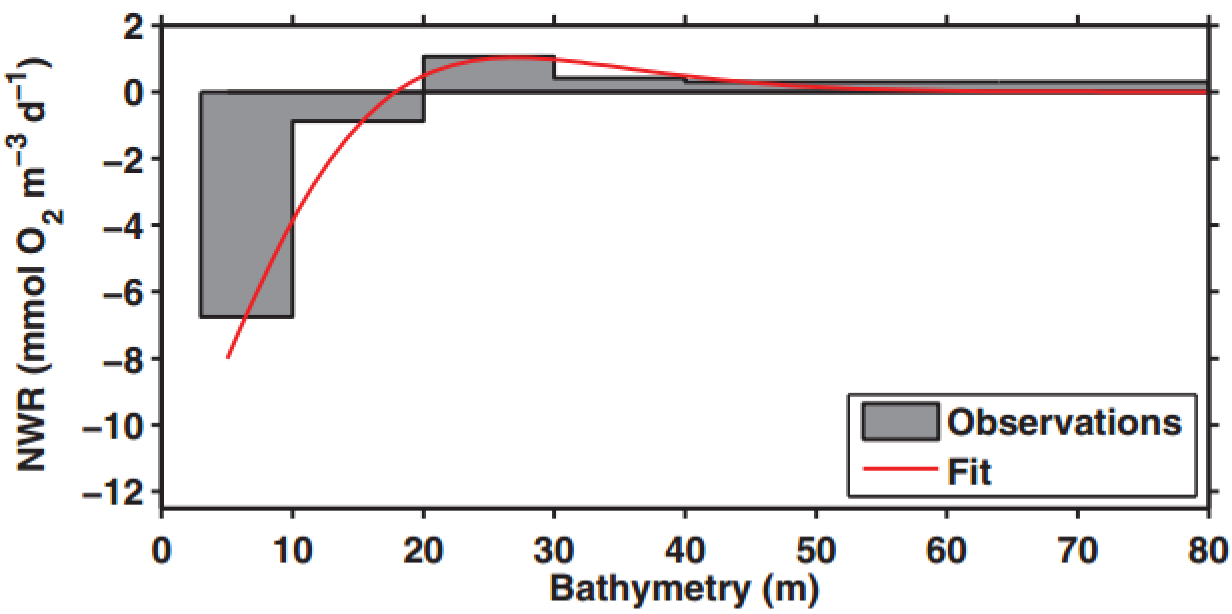
Evidence of deep water intrusion from modeling results



Two-layer circulation structure in Halifax Harbour (from Fader and Miller 2008)



- The three-dimensional circulation model coupled with a simple oxygen model will be used to study the physical processes affecting dissolved oxygen concentration in deep Bedford Basin.



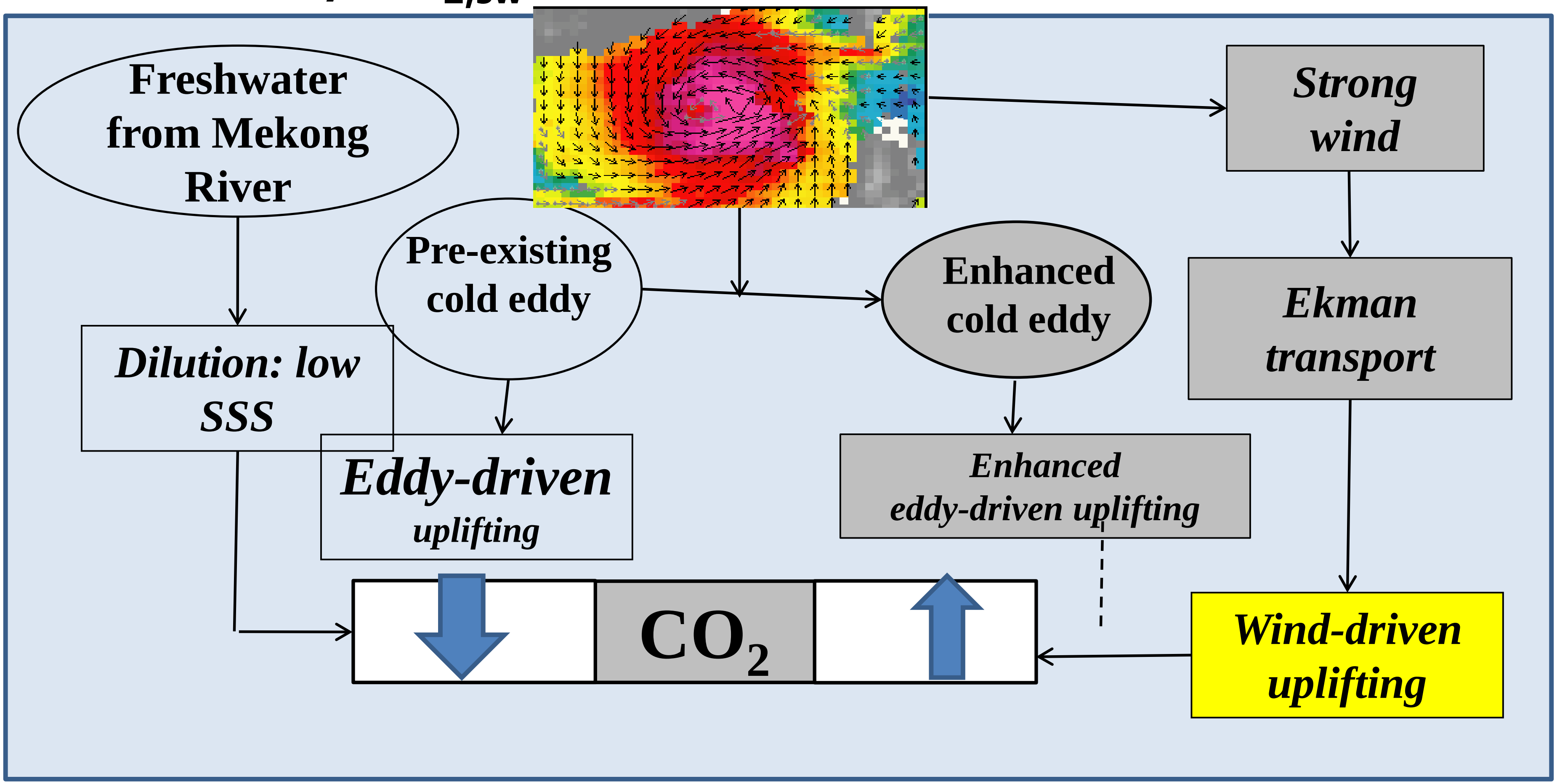
(Courtesy to Liuqian and Fennel, 2014).

Timelines

Period	Activities
2017	Paper published in Satell Oceanogr Meteorol: “Circulation, dispersion and hydrodynamic connectivity over the Scotian Shelf and adjacent waters”
Oct. 2018	Proposal defense
Oct. 2018 – Nov. 2018	Modify and submit the paper: “numerical study of the storm-induced circulation in the South China Sea”
Nov. 2018	Sea time (Dalhousie-BIOS Experiential Learning Funding)
Nov. 2018 – Feb. 2019	Continuing to work on: “the physical processes affecting dissolved oxygen concentration in deep Bedford Basin”
Feb. 2018 – Apr. 2019	Thesis writing
May - 2019	Thesis Defense

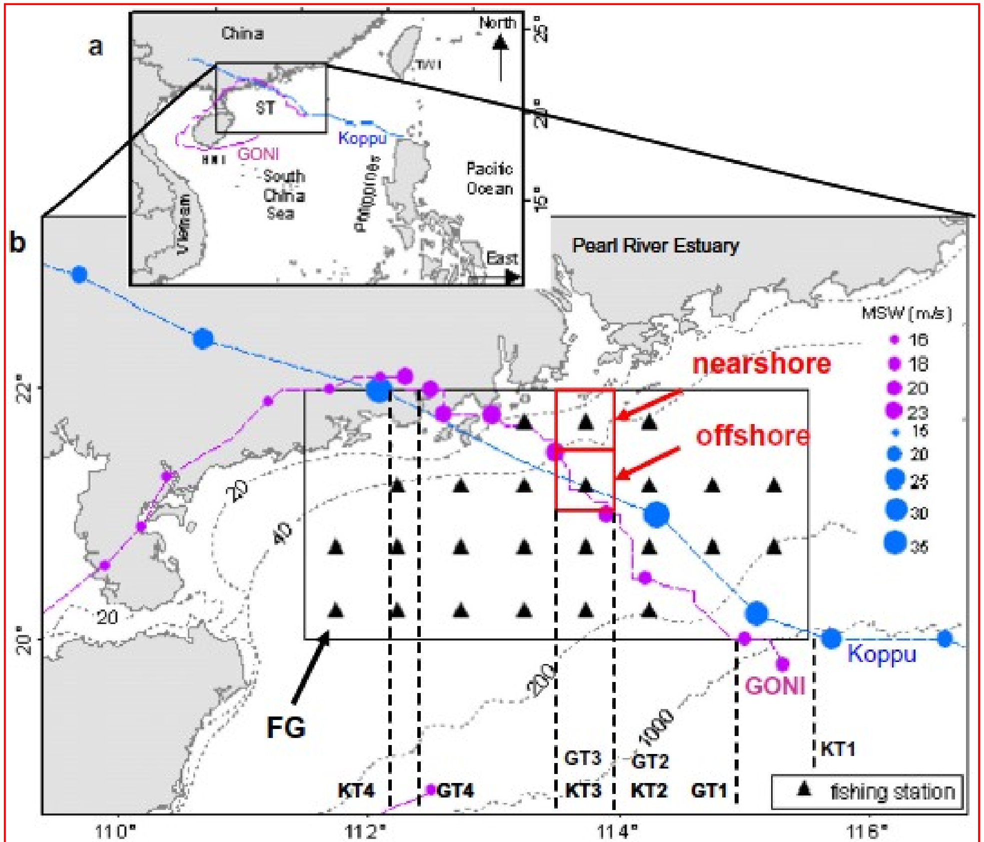
1. Surface water diluted by heavy rain, with low $pCO_{2,sw}$

2. TD uplifting eddy-driven high $pCO_{2,sw}$



change temporarily

(1) Increase in fish abundance during two typhoons in the South China Sea



GONI: 20:00 Aug 3(Begin)-14:00 Aug 9(End)

Koppu: 02:00 Sep 13(Begin)-05:00 Sep 16(End)

GT4: 13:00 Aug 5 KT4: 08:00 Sep 15

GT3: 20:00 Aug 4 KT3: 01:00 Sep 15

GT2: 13:00 Aug 4 KT2: 20:00 Sep 14

GT1: 02:00 Aug 4 KT1: 09:00 Sep 14

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SciVerse ScienceDirect

Advances in Space Research 51 (2013) 1734–1749

ADVANCES IN SPACE RESEARCH (a COSPAR publication)

www.elsevier.com/locate/asr

Increase in fish abundance during two typhoons in the South China Sea

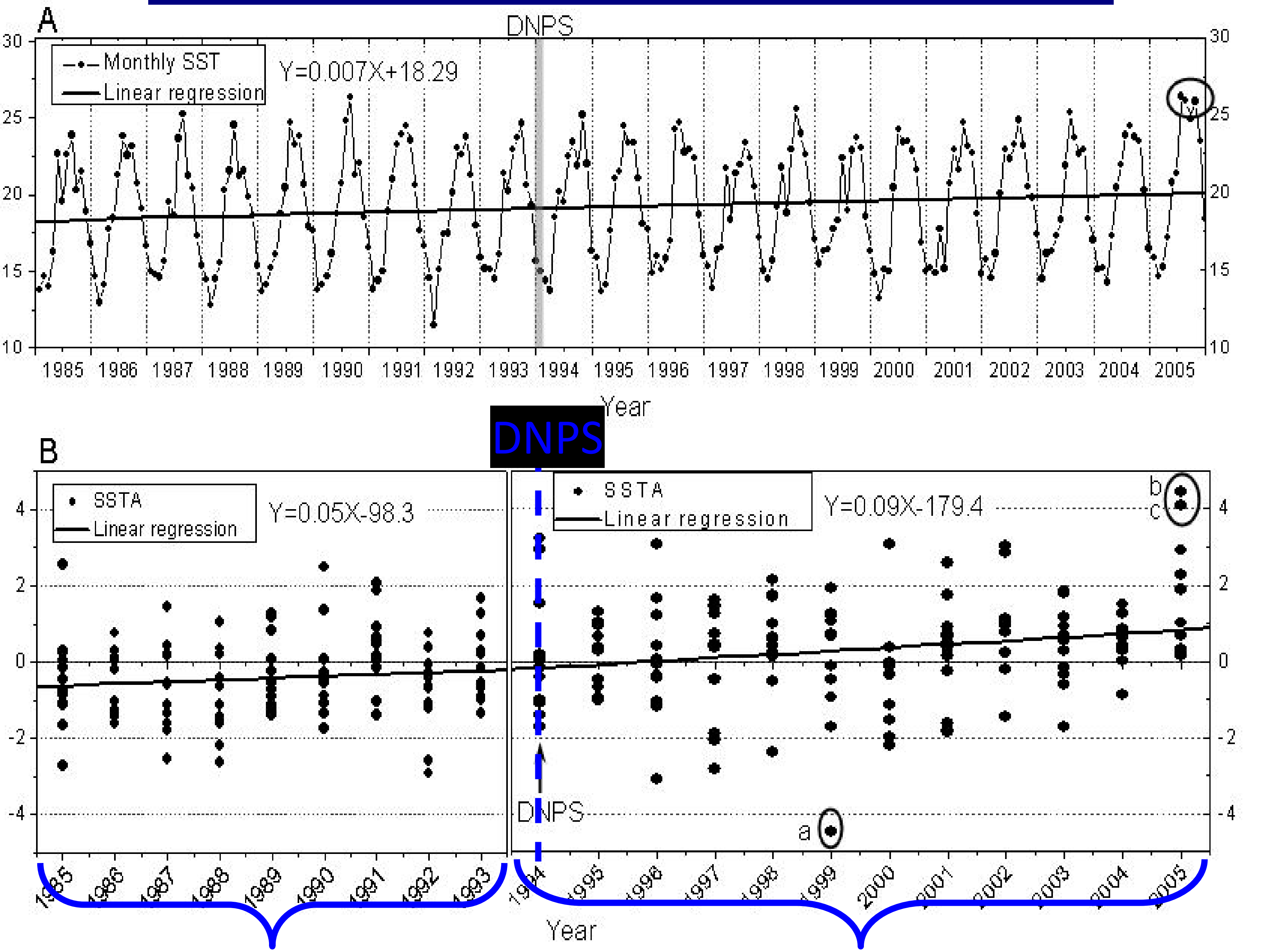
Jie Yu[a,b,c], Danling Tang[a,c,*], Yongzhen Li[b], Zirong Huang[b], Guobao Chen[b]

Yu & Tang, 2013, ASR

Seasonal variation of SST

Monthly SST

Ascending trend



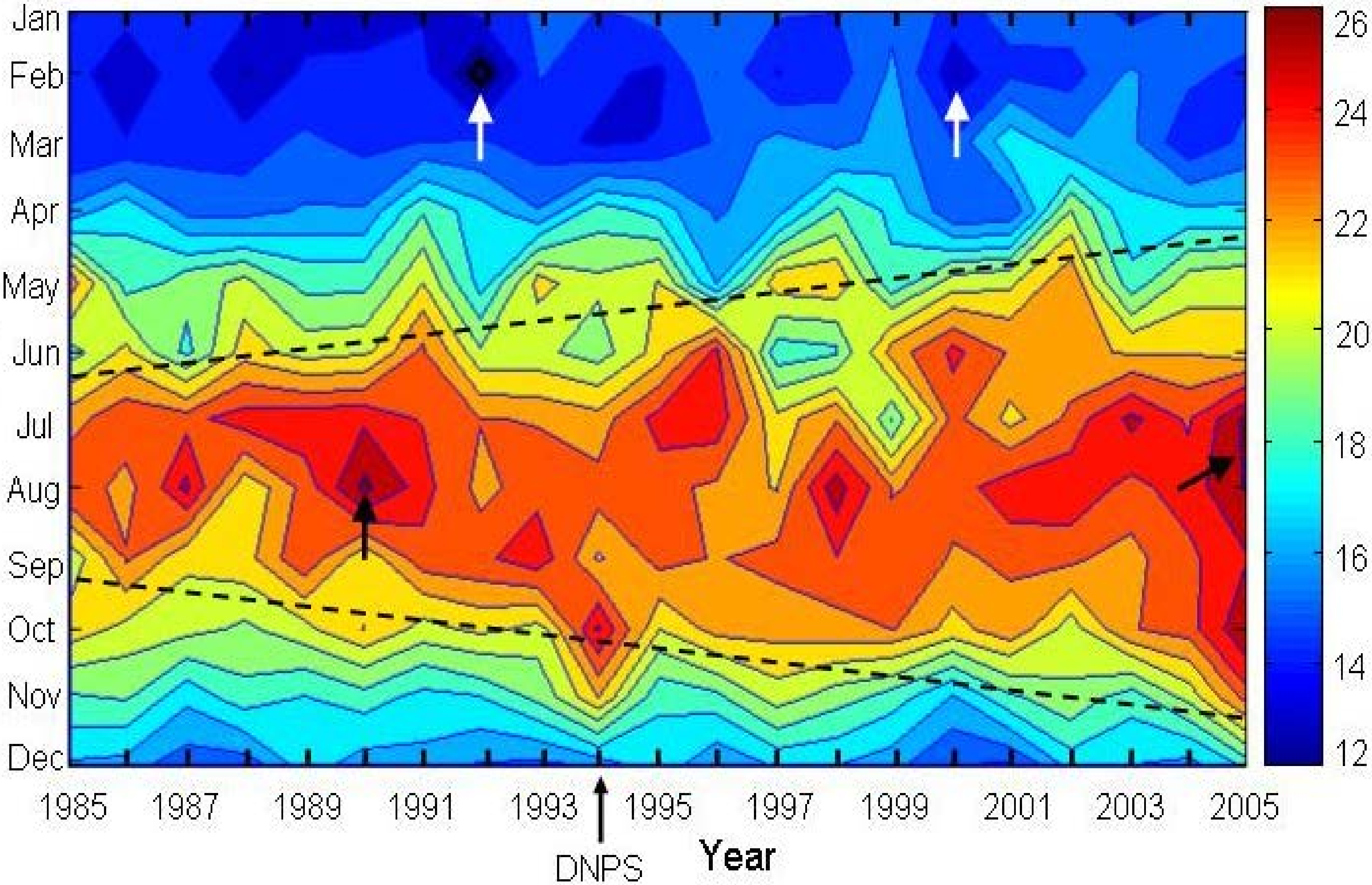
Monthly SSTA

Global warming

Thermal discharge

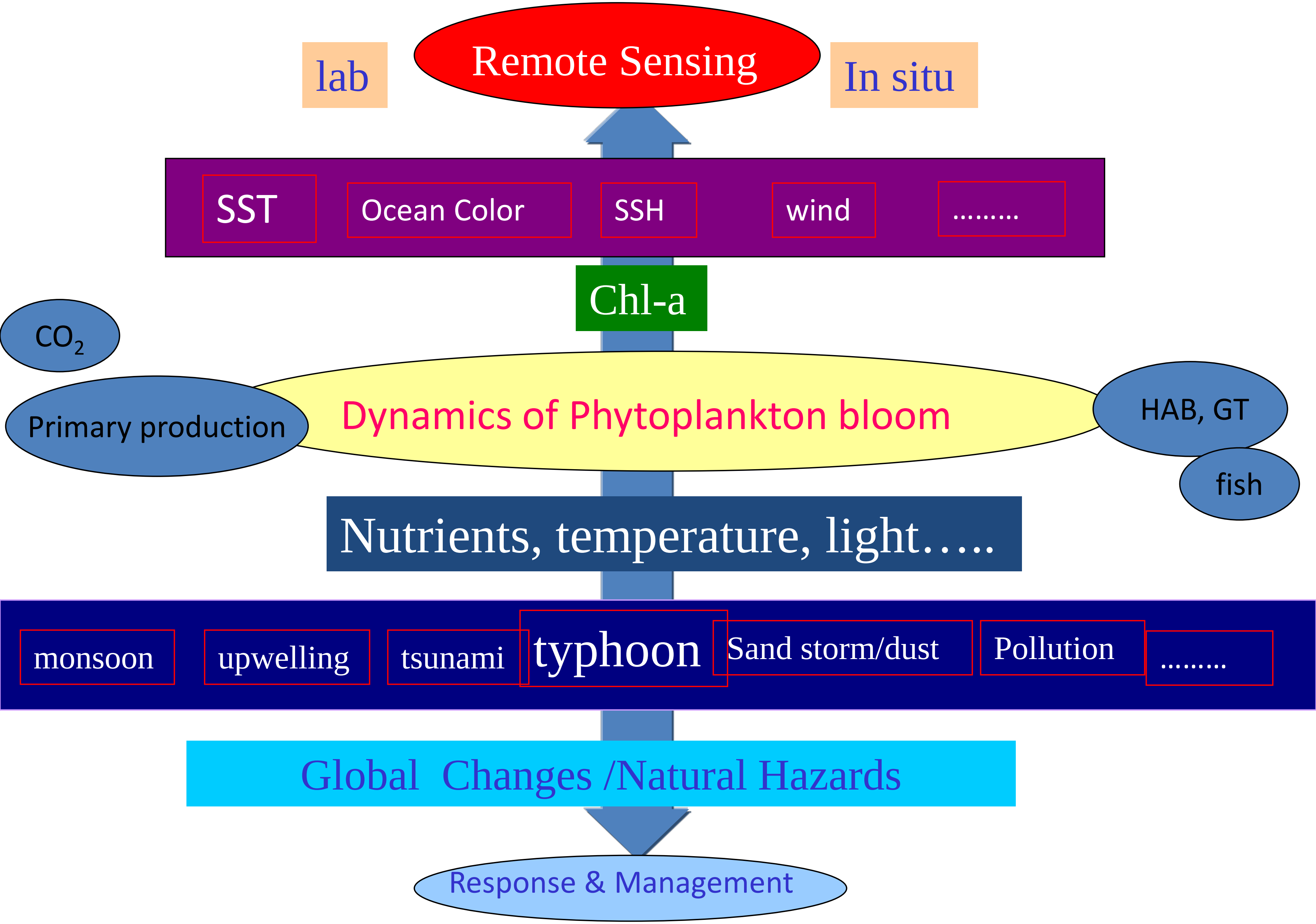
Increasing of Monthly (1985-2005)

Month



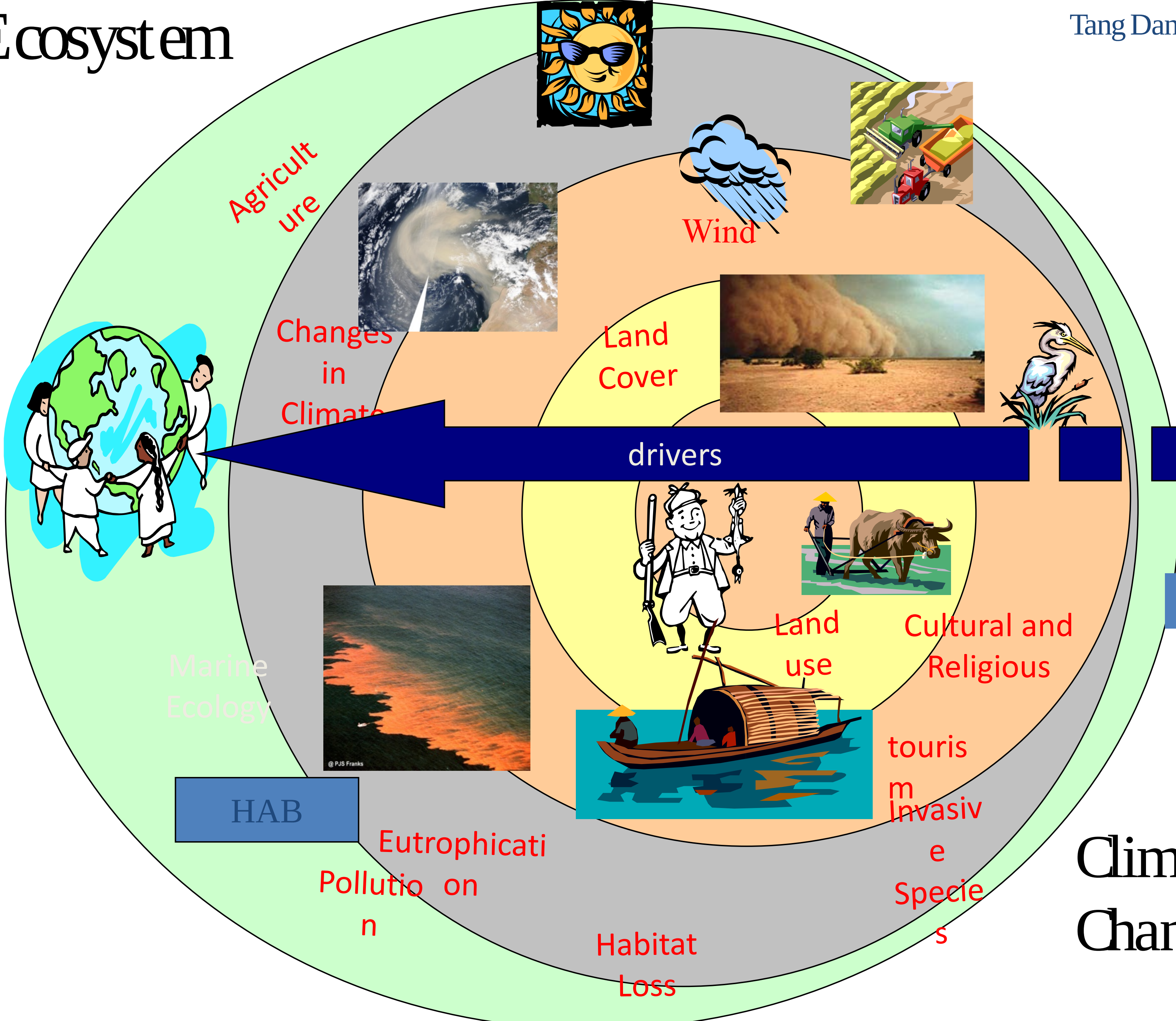
??

Increase of SST; Seasonal extension of higher SST


lab
Remote Sensing
In situ
SST
Ocean Color
SSH
wind
………
Chl-a
CO_2
Primary production
Dynamics of Phytoplankton bloom
HAB, GT
fish
Nutrients, temperature, light…..
monsoon
upwelling
tsunami
typhoon
Sand storm/dust
Pollution
………
Global Changes /Natural Hazards
Response & Management

Ecosystem

Tang DanLing 唐丹玲



Drivers

Climate
Changs

遥感海洋生态科学

太空
传感器
生物生态
遥感的普及、大数据
新的理念

Welcome to

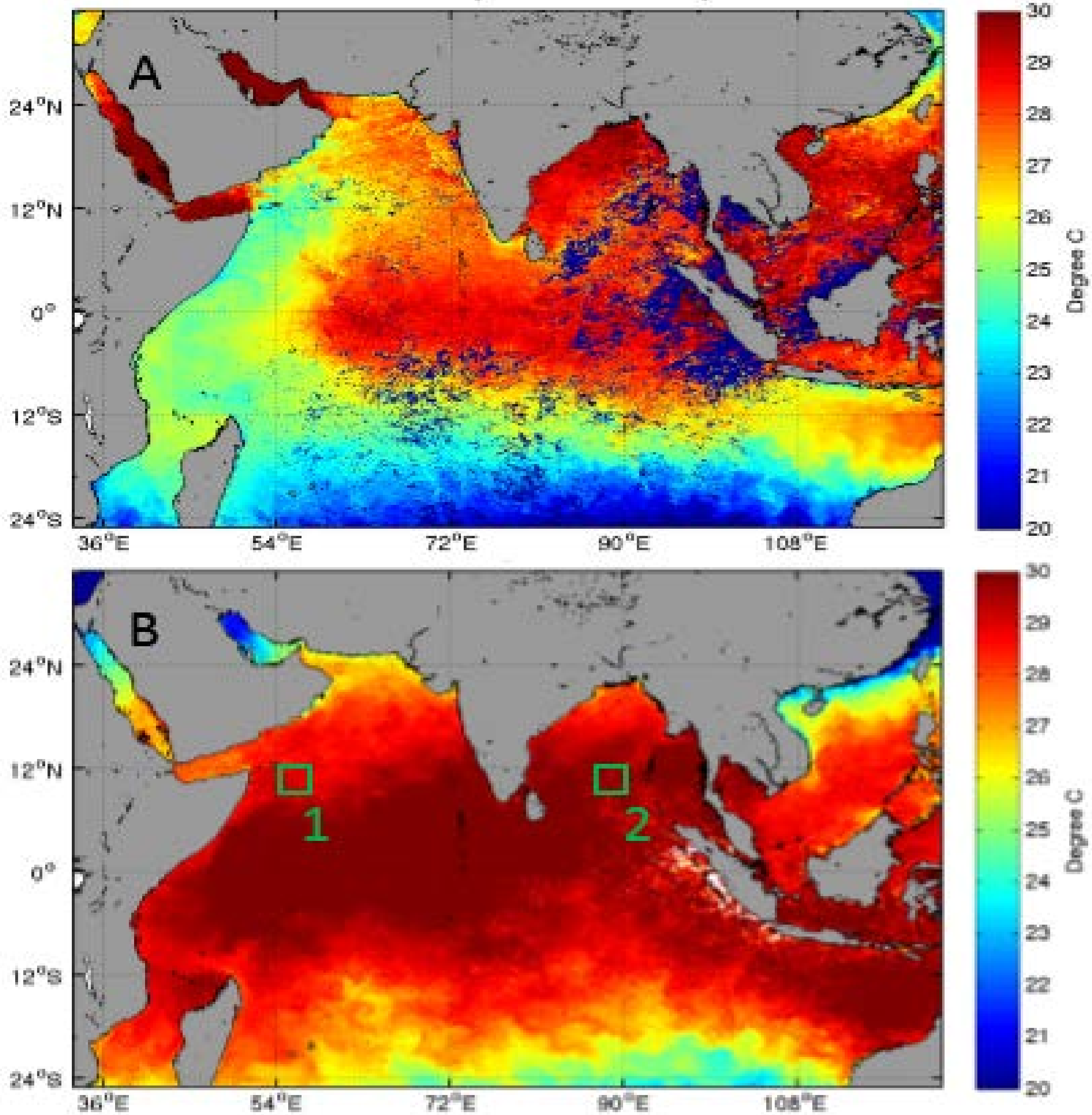
25th PACON

March， 2017, Zhoushang， China

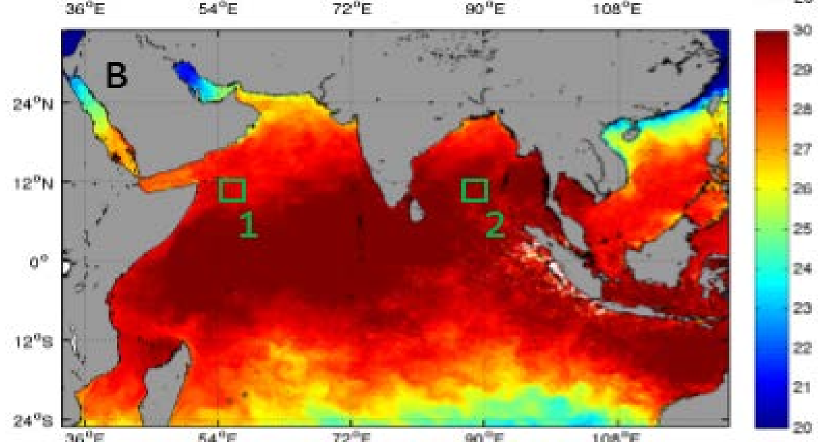
丝绸之路
的海洋遥感

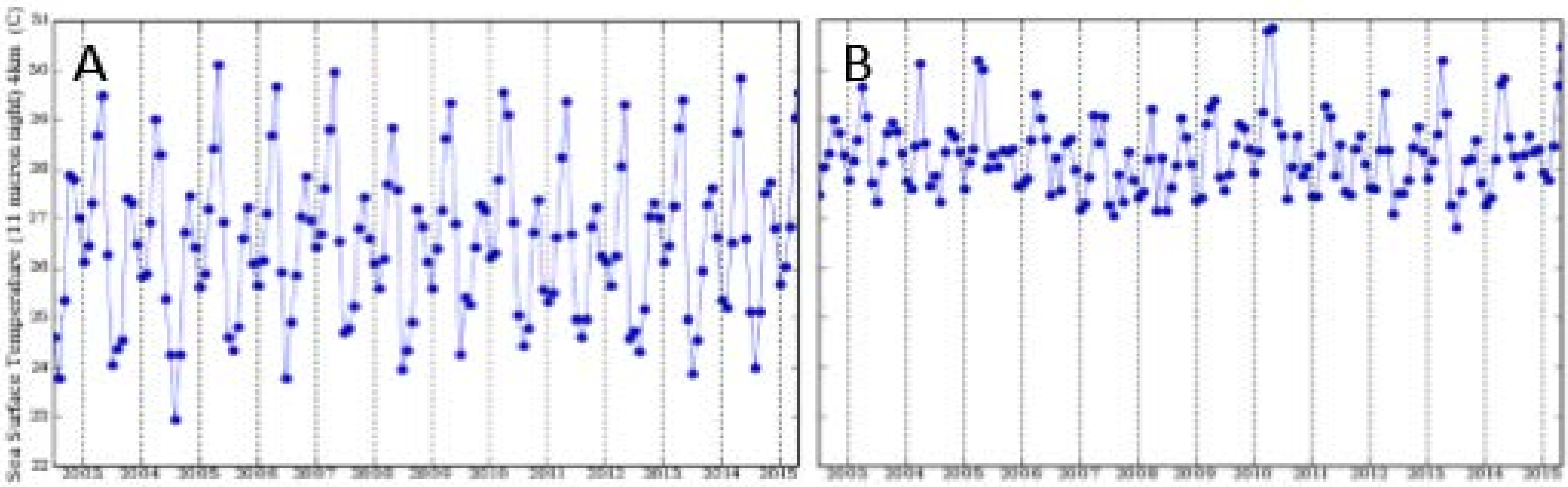
Available satellite remote sensing

Variables	Production	Sensor	Duration
SST	Pathfinder monthly SST	AVHRR/NOAA	1981.09 – 2006.12
	Monthly 11um Night SST	MODIS/Aqua	2002.07 - present
	Level-2 EDR SST	VIIRS/SuomiNPP	2012.01 - present
Chl	Chlorophyll concentration	CZCS	1978.10 - 1986.06
	Chlorophyll concentration	OCTS	1996.11 - 1997.06
	Chlorophyll concentration	SeaWiFS	1997.09 - 2010.12
	OCI algorithm Chlorophyll	MODIS/Auqa	2002.07 - present
	OCI algorithm Chlorophyll	VIIRS/SuomiNPP	2012.01 - present
SSS	Sea surface salinity V4.0	Aquarius	2011.08 - present
	Level 2 Ocean Salinity	SMOS	2010.12 - present
SSH	Sea level	TOPEX/Poseidon	1992.08 – 2005.12
	Sea level	Jason-1	2002.01 – 2013.06
Sea wind	Sea surface winds	SeaSat	1978.06 – 1978.10
	Weekly sea wind	QuikSCAT	1999.07 – 2009.11
	Sea wind	ASCAT/Metop-A	2006.10 – 2007.04
Rainfall	3B43	TRMM	1998.01 - present

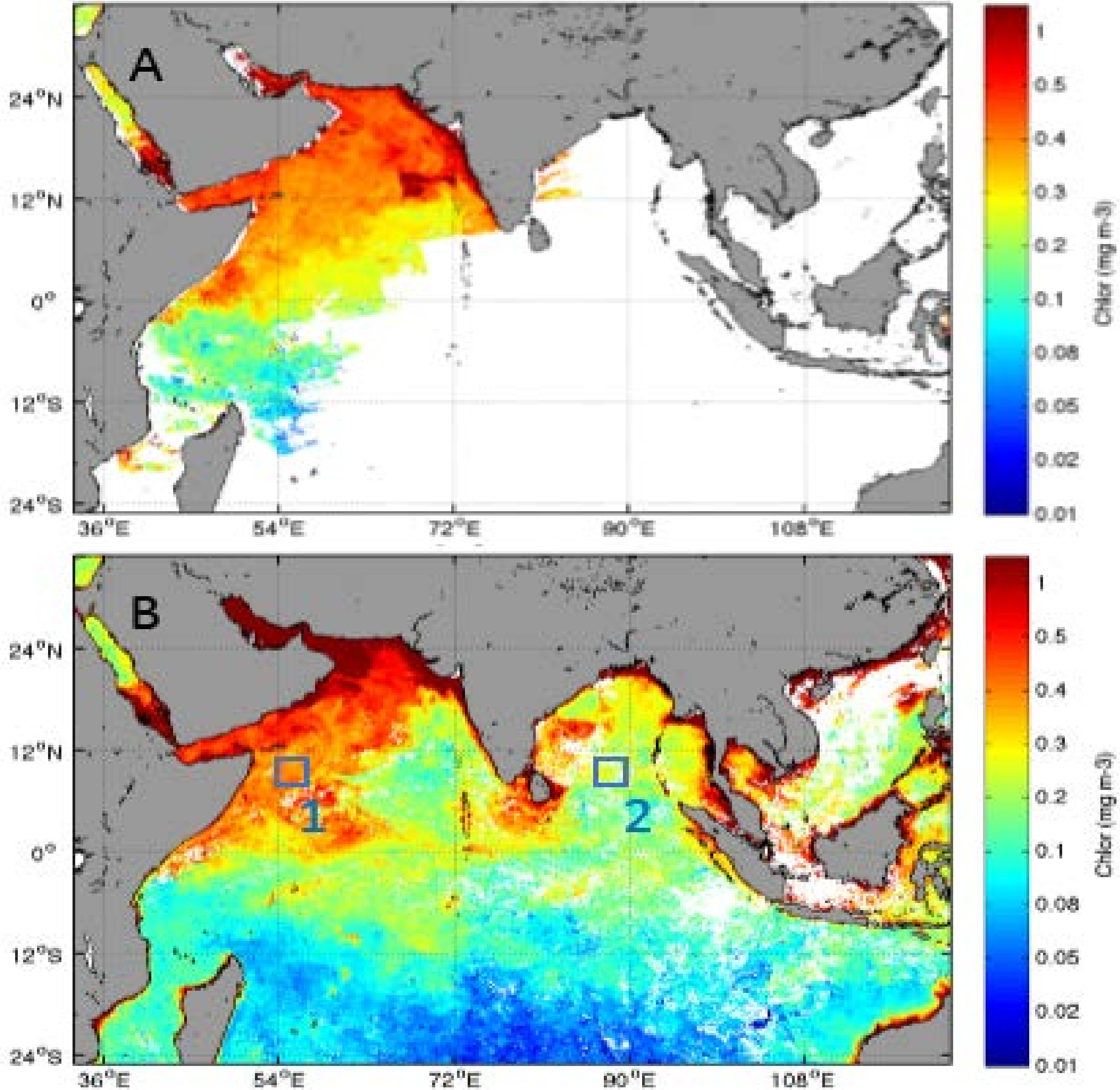


Monthly averaged SST data in different time. (A) SST derived from the AVHRR sensor onboard the satellite NOAA-7 in September 1981, and (B) SST derived from the MODIS sensor onboard the satellite Aqua in April 2015.

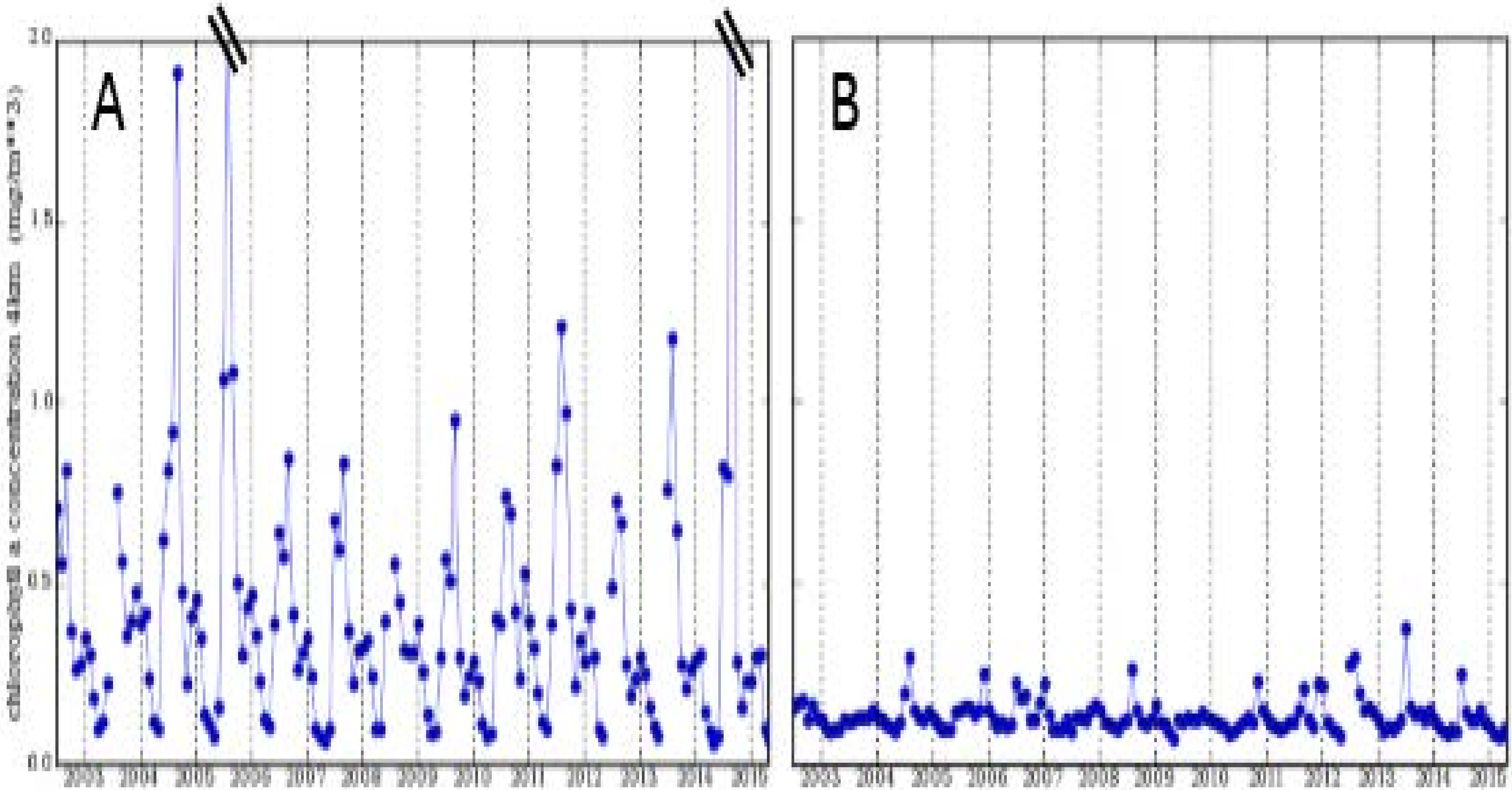




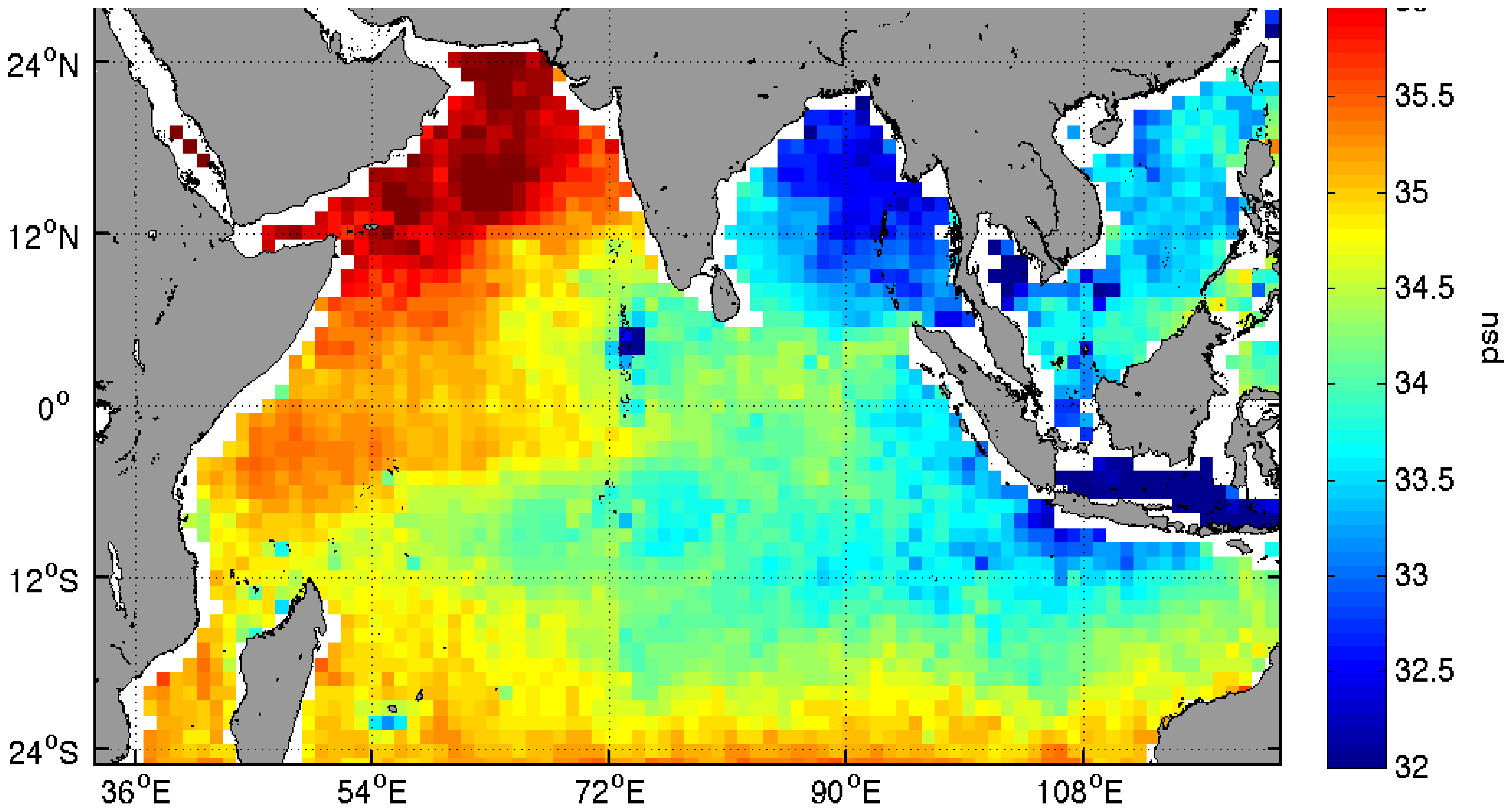
Area-averaged time series MODIS/Aqua night SST 4km resolution during Jul 2002 – May 2015



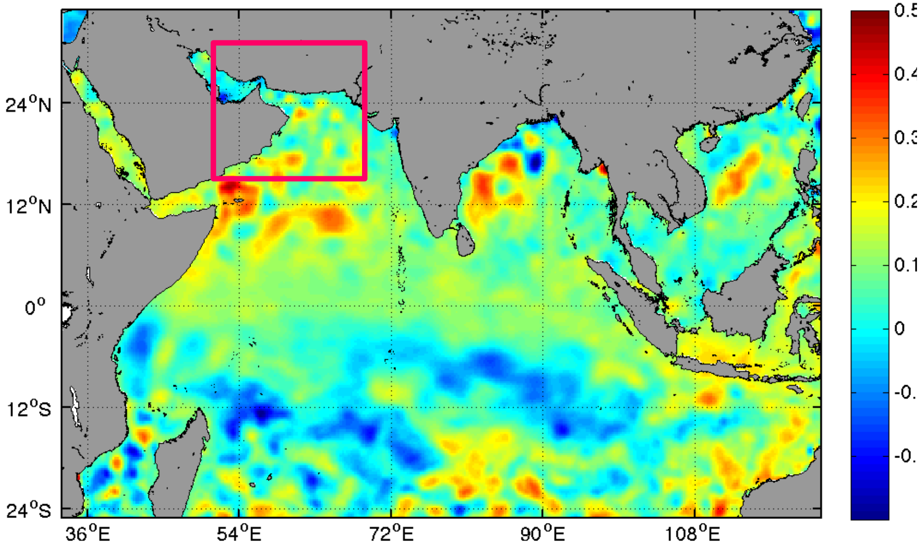
Monthly averaged Chlorophyll concentration in December in different year. (A) Chl derived from CZCS data in 1978, and (B) Chl derived from MODIS/Aqua in 2014.

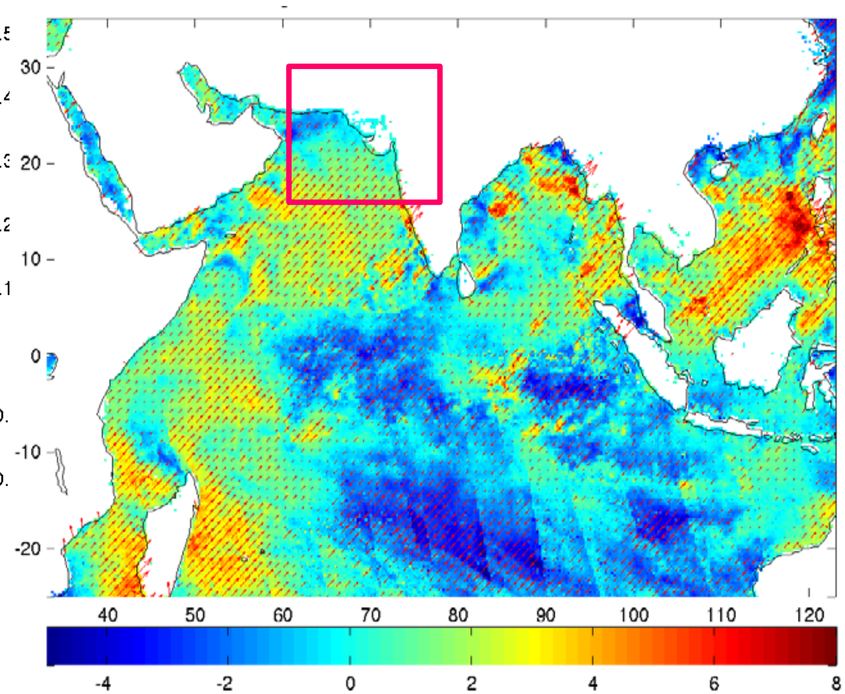


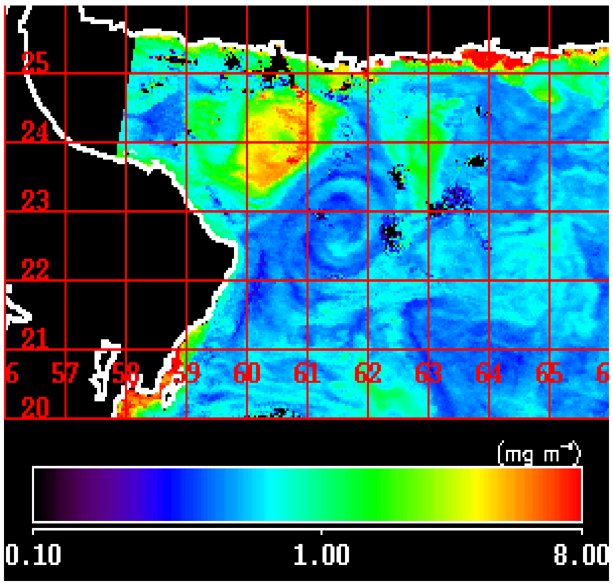
Area-averaged time series MODIS/Aqua Chlorophyll 4km resolution during Jul 2002 – May 2015. Region 54-57E, 9-12N (A), and region 87-90E, 9-12N (B), which corresponding to the blue boxes 1 and 2 in Fig. 4B, respectively.

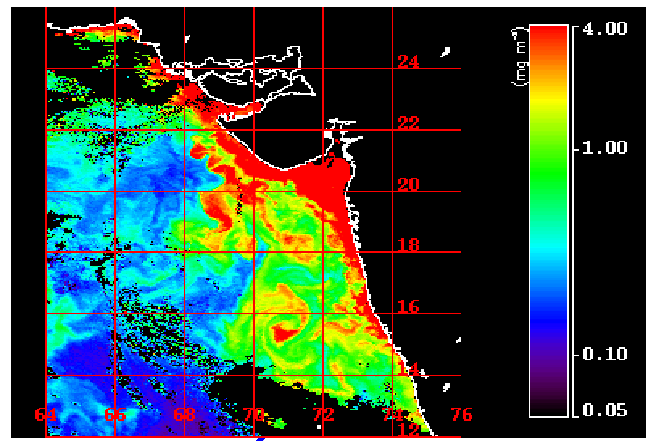


Monthly SSS in Apr 2015. Data from http://oceancolor.gsfc.nasa.gov/cgi/l3

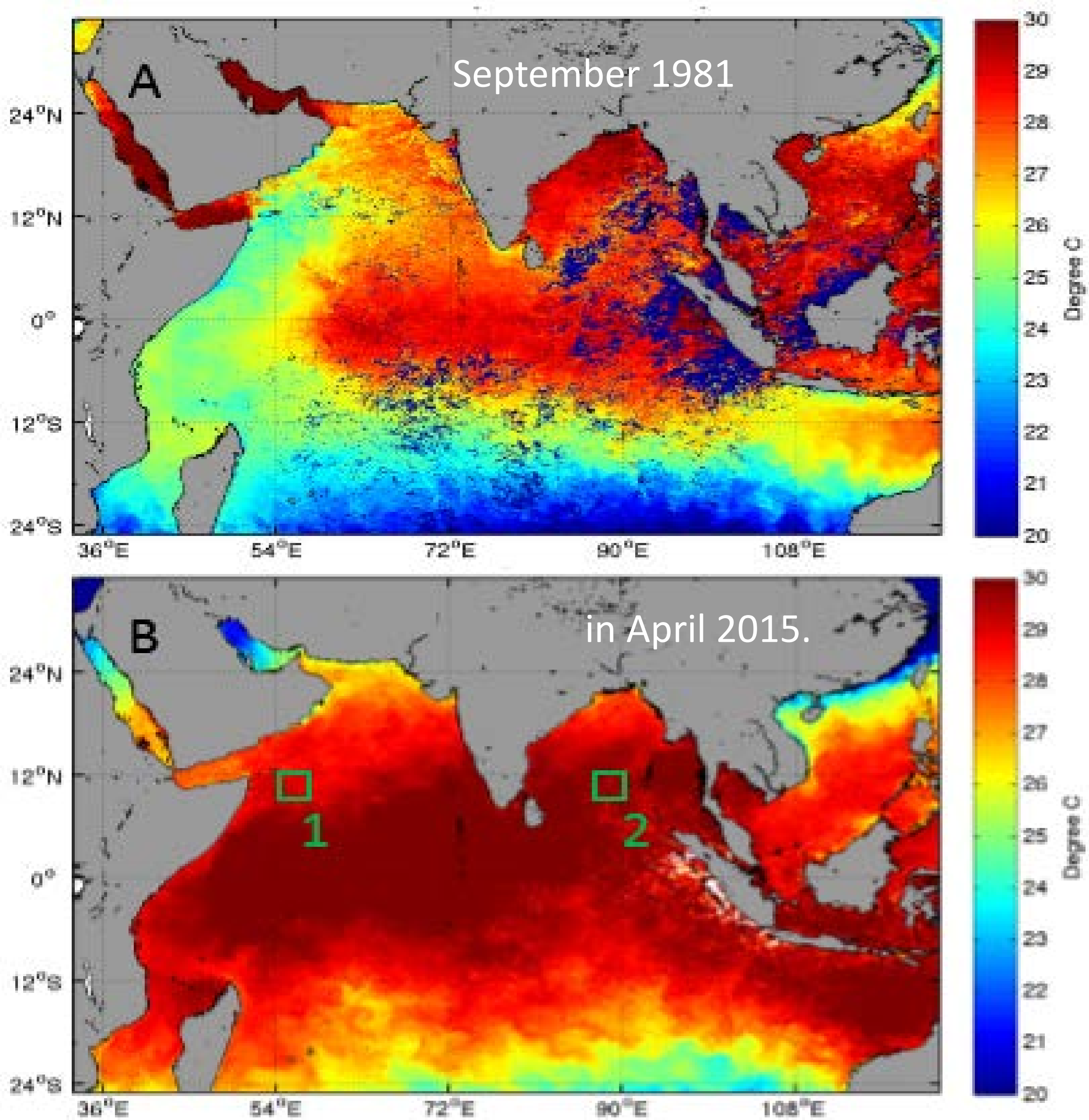




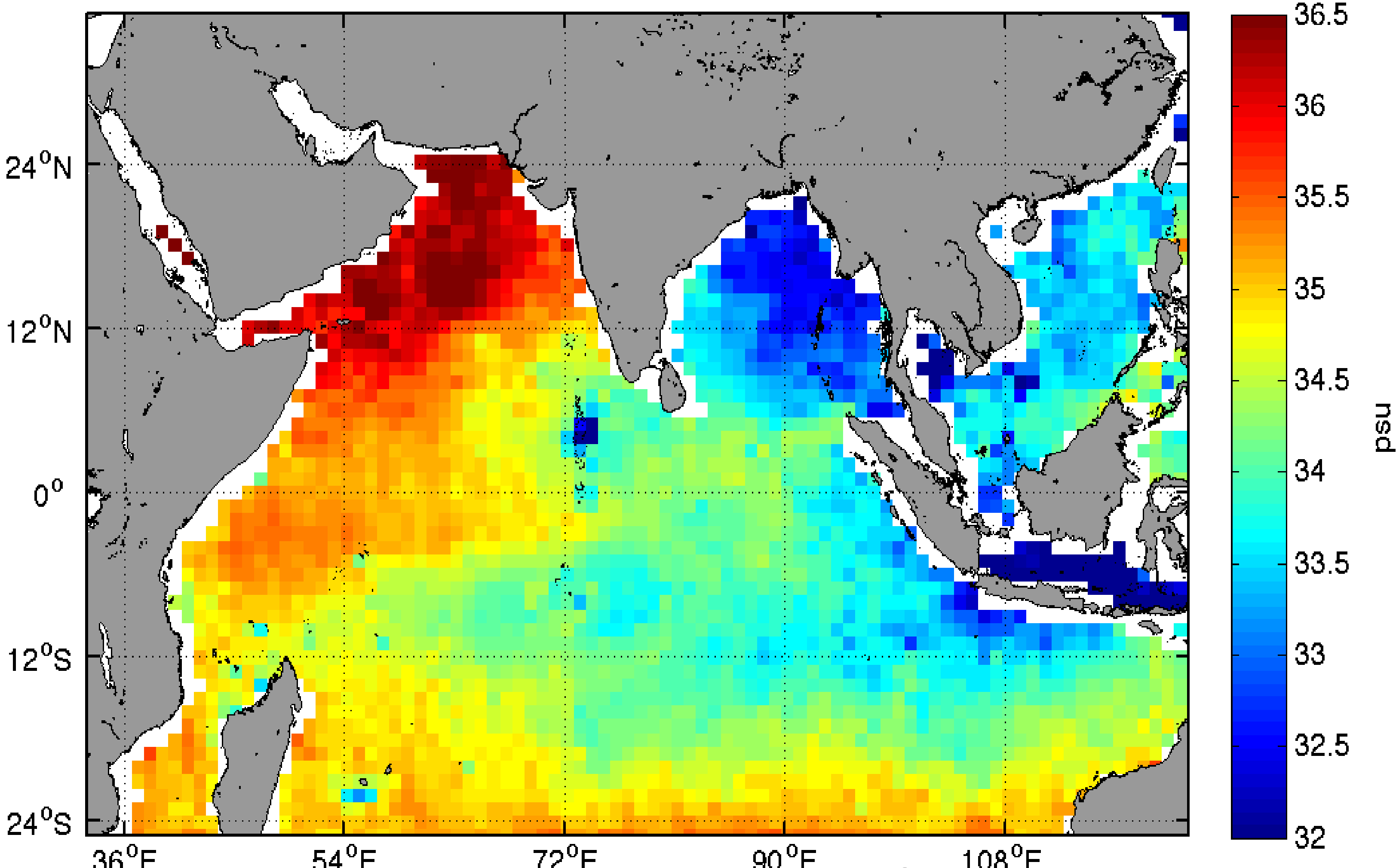




A snapshot of sea level anomaly on Apr 29, 2013. The spatial resolution is 1/4° x1/4° .


A
September 1981
B
in April 2015.
1
2
24°N
12°N
0°
12°S
24°S
36°E
54°E
72°E
90°E
108°E
Degree C
30
29
28
27
26
25
24
23
22
21
20

SST data

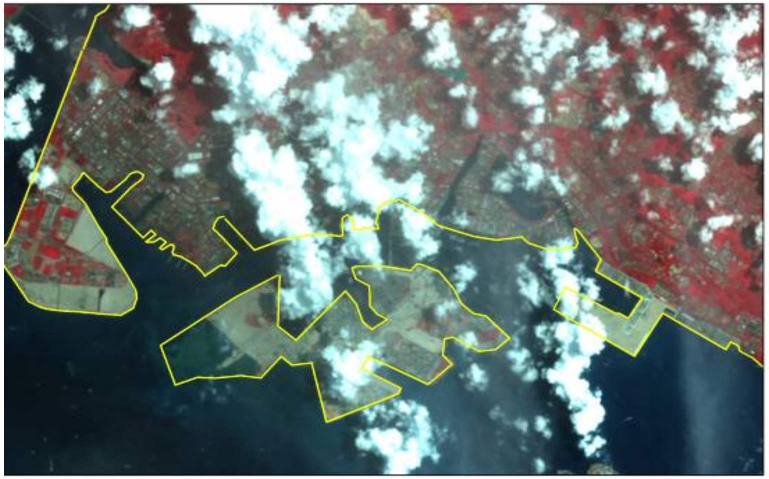


Monthly SSS in Apr 2015. Data from http://oceancolor.gsfc.nasa.gov/cgi/l3

Coastline monitoring

Landsat MSS， 1973/10/17

Landsat TM， 1989/08/20

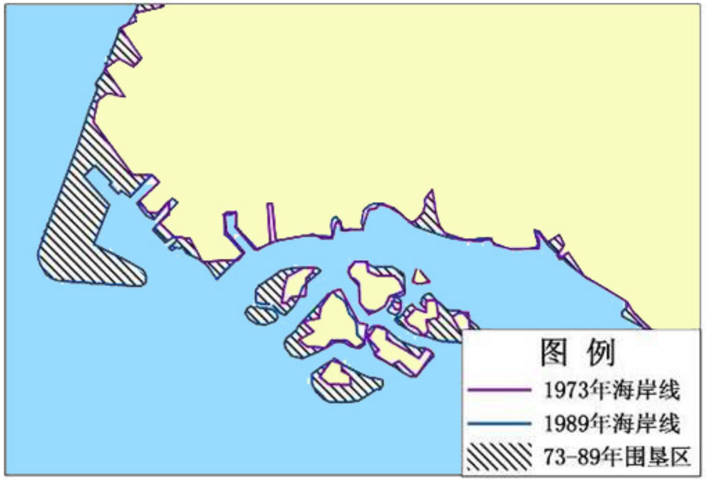


Landsat ETM+， 1999/09/01

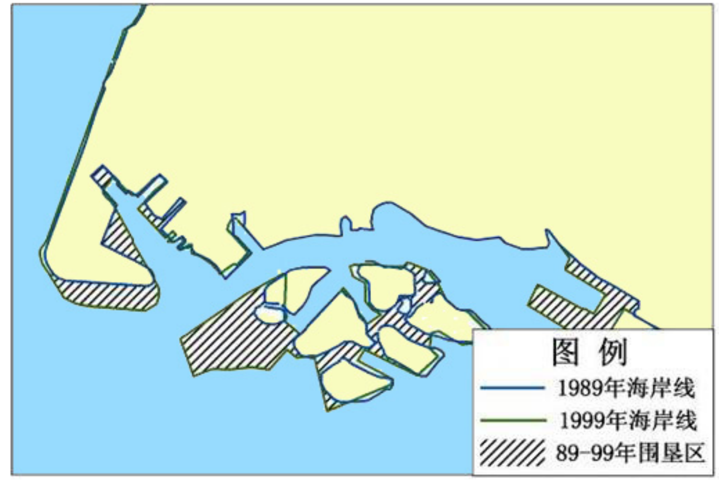
Landsat ETM+， 2002/04/02

Coastline monitoring in the southwest of Singapore.

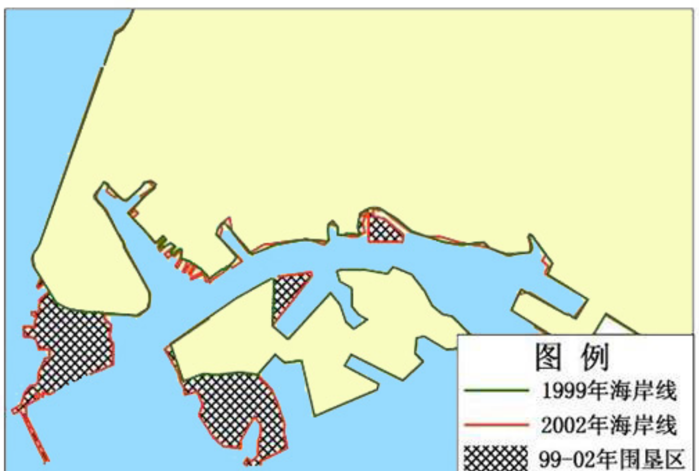
Coastline monitoring



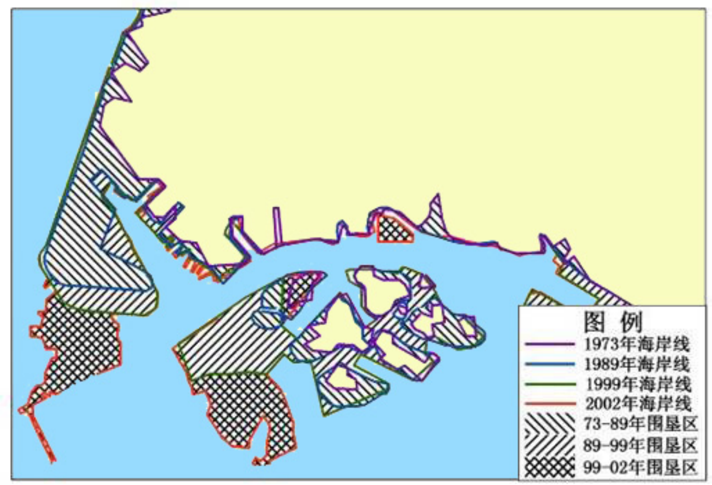
Coastline Change (1973-1989)



Coastline Change (1989-1999)



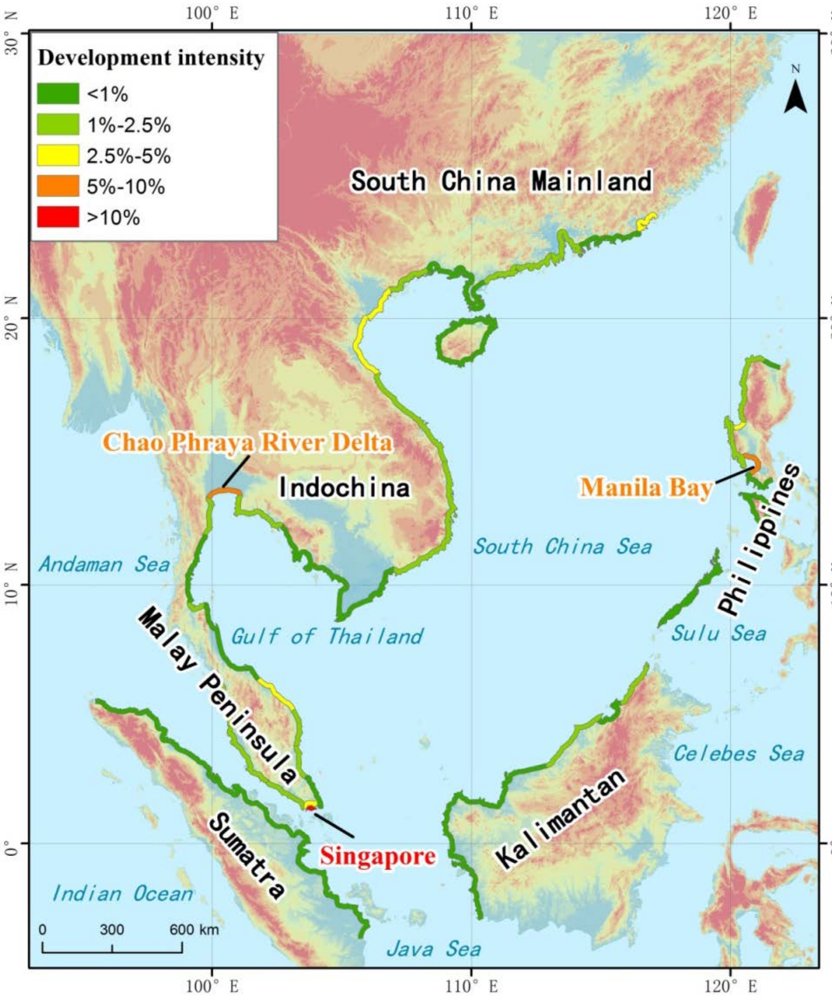
Coastline Change (1999-2002)



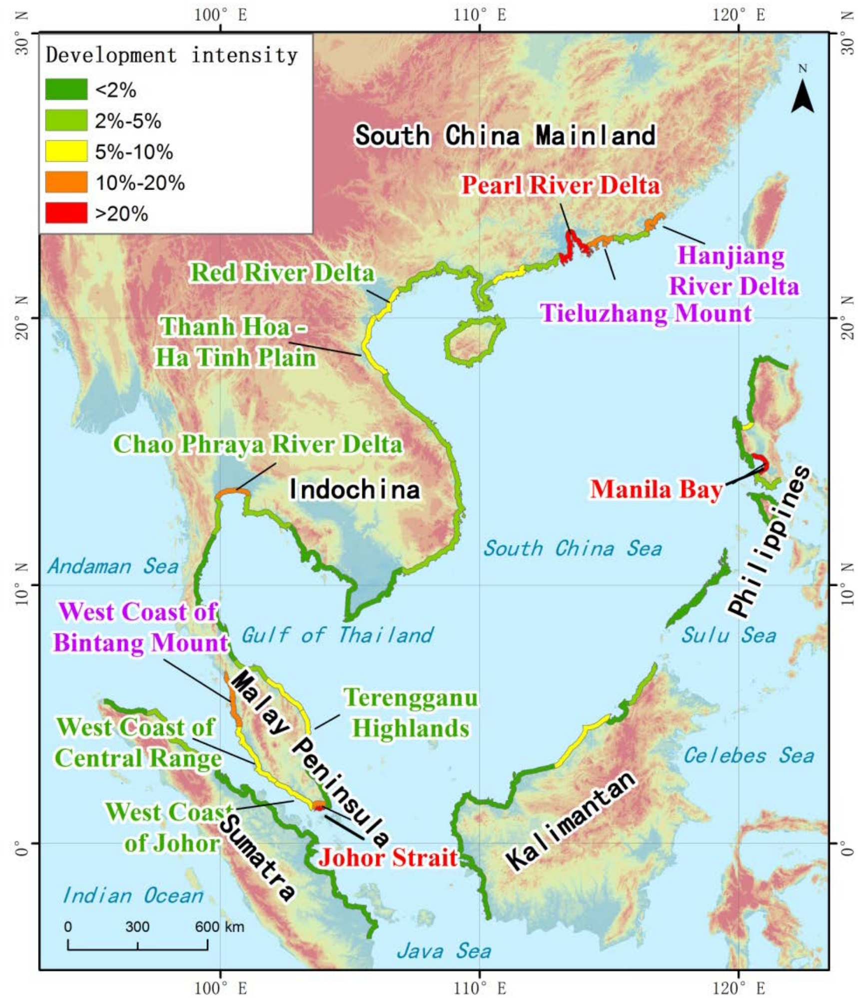
Coastline Change (1973-2002)

Coastline monitoring in the southwest of Singapore.

Spatial differentiation



1975



2010

In 35 years, the expansion rate of construction area was rapid.

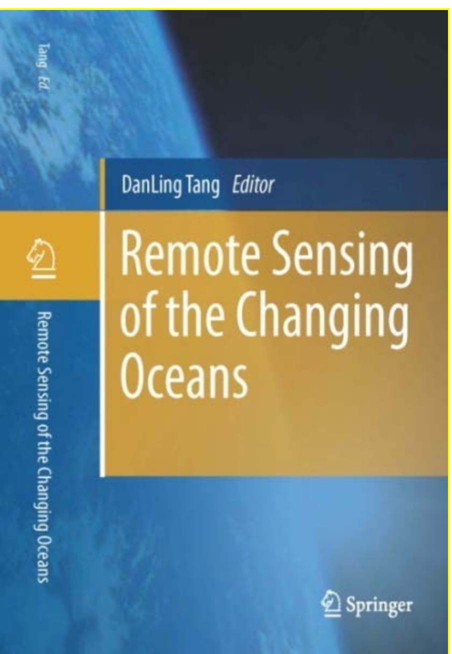
DanLing TANG (lingzis)

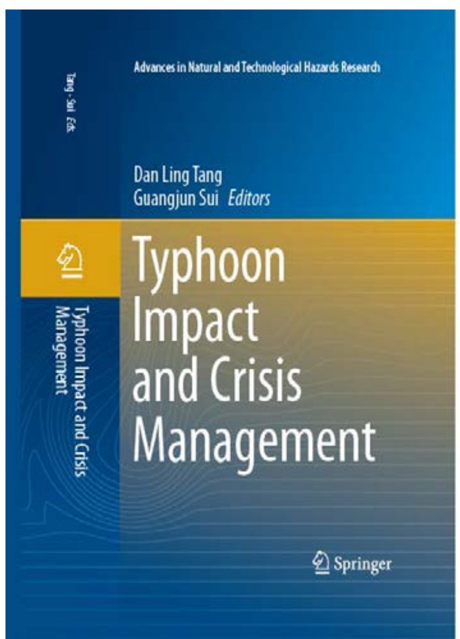
Thank You!

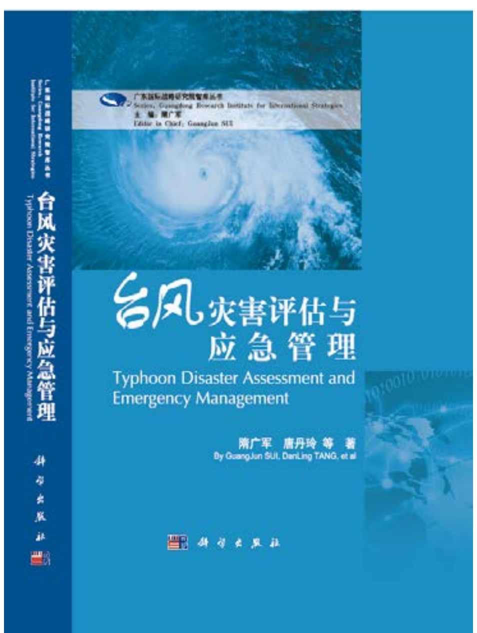
Springer
the language of science

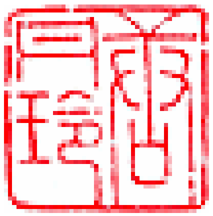
South China Sea Institute of Oceanology

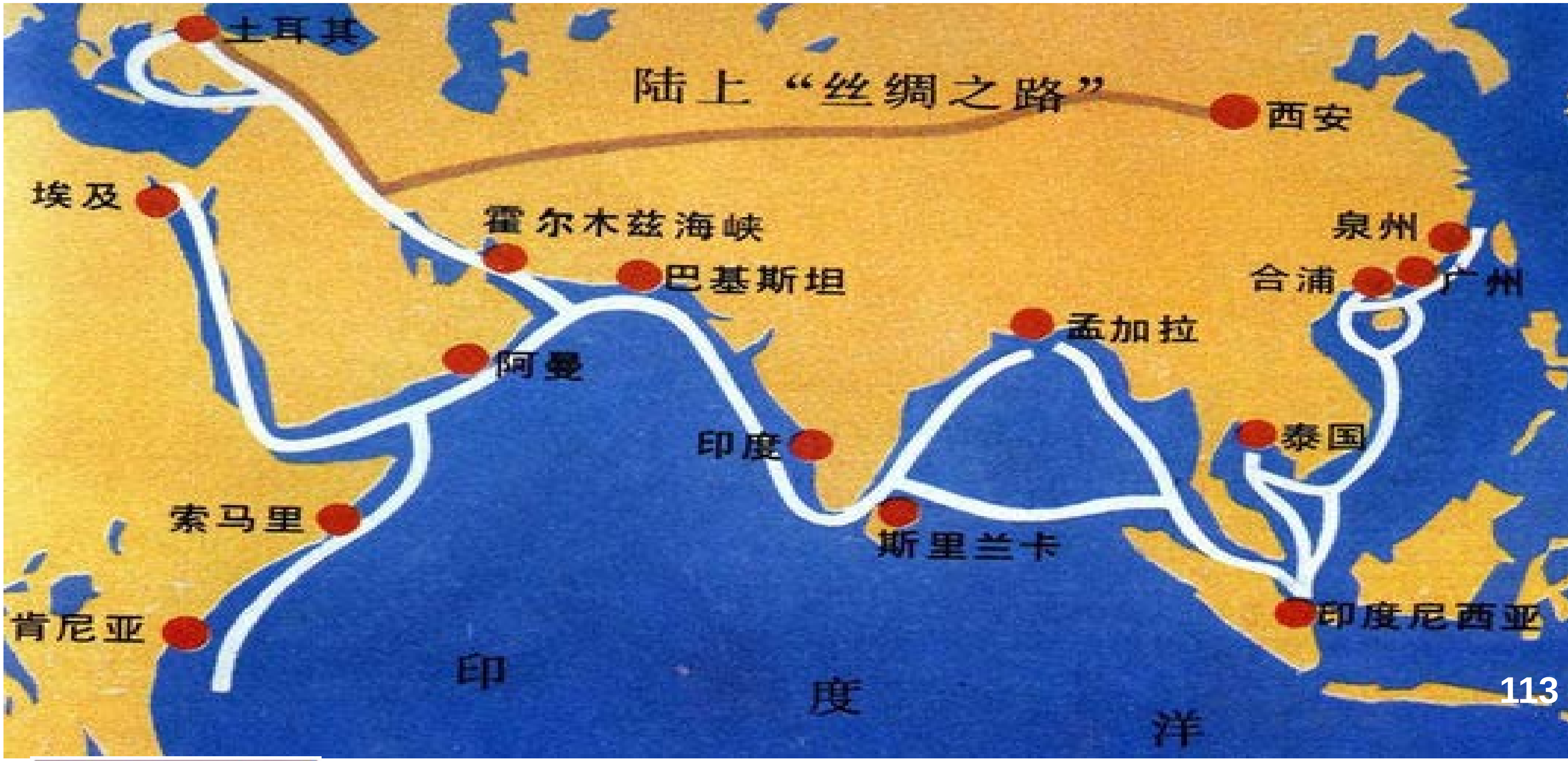
Chinese Academy of Sciences







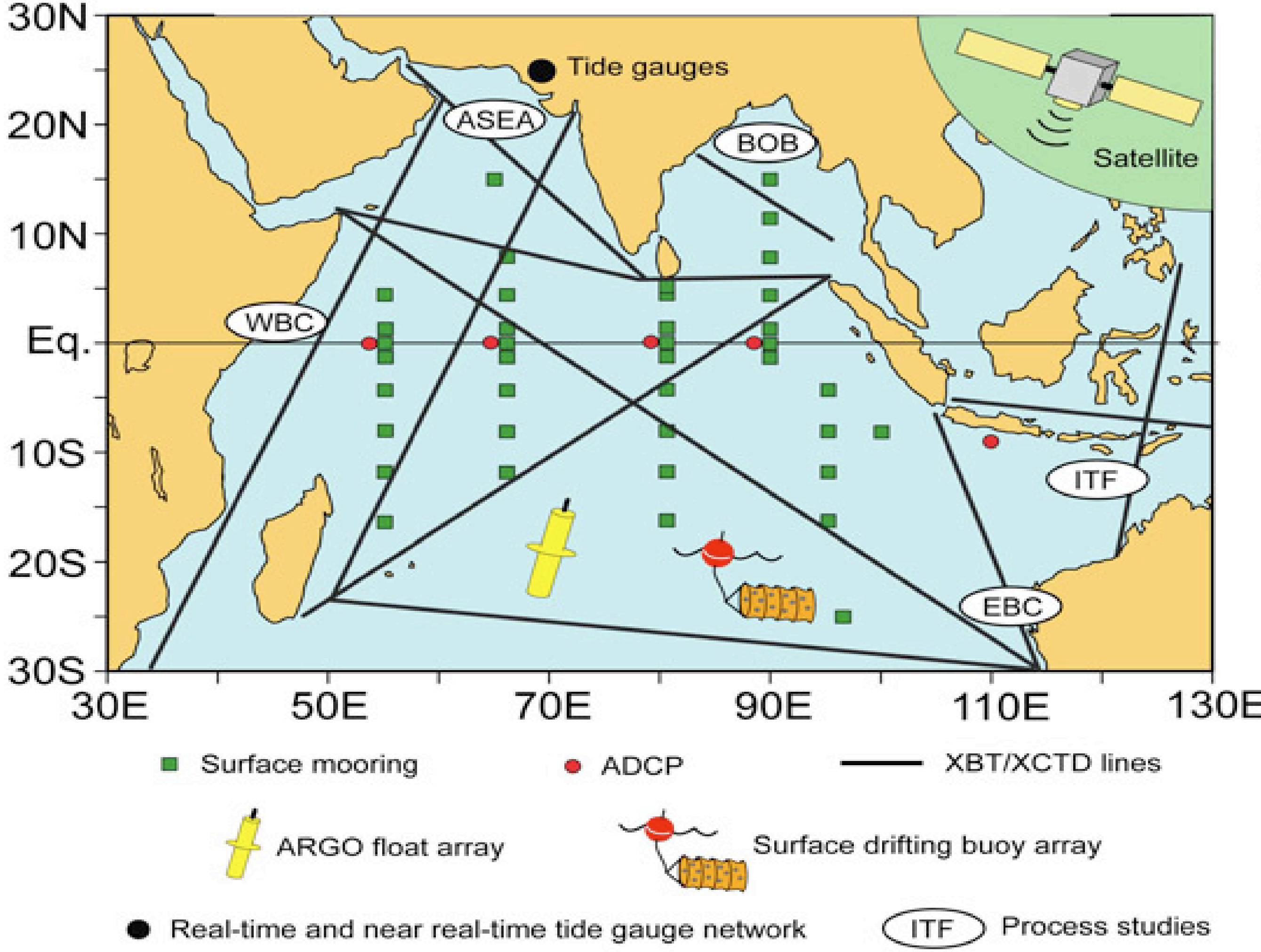



土耳其
陆上“丝绸之路”
西安
埃及
霍尔木兹海峡
巴基斯坦
泉州
合浦
广州
阿曼
孟加拉
印度
泰国
索马里
斯里兰卡
肯尼亚
印度尼西亚
印
度
洋

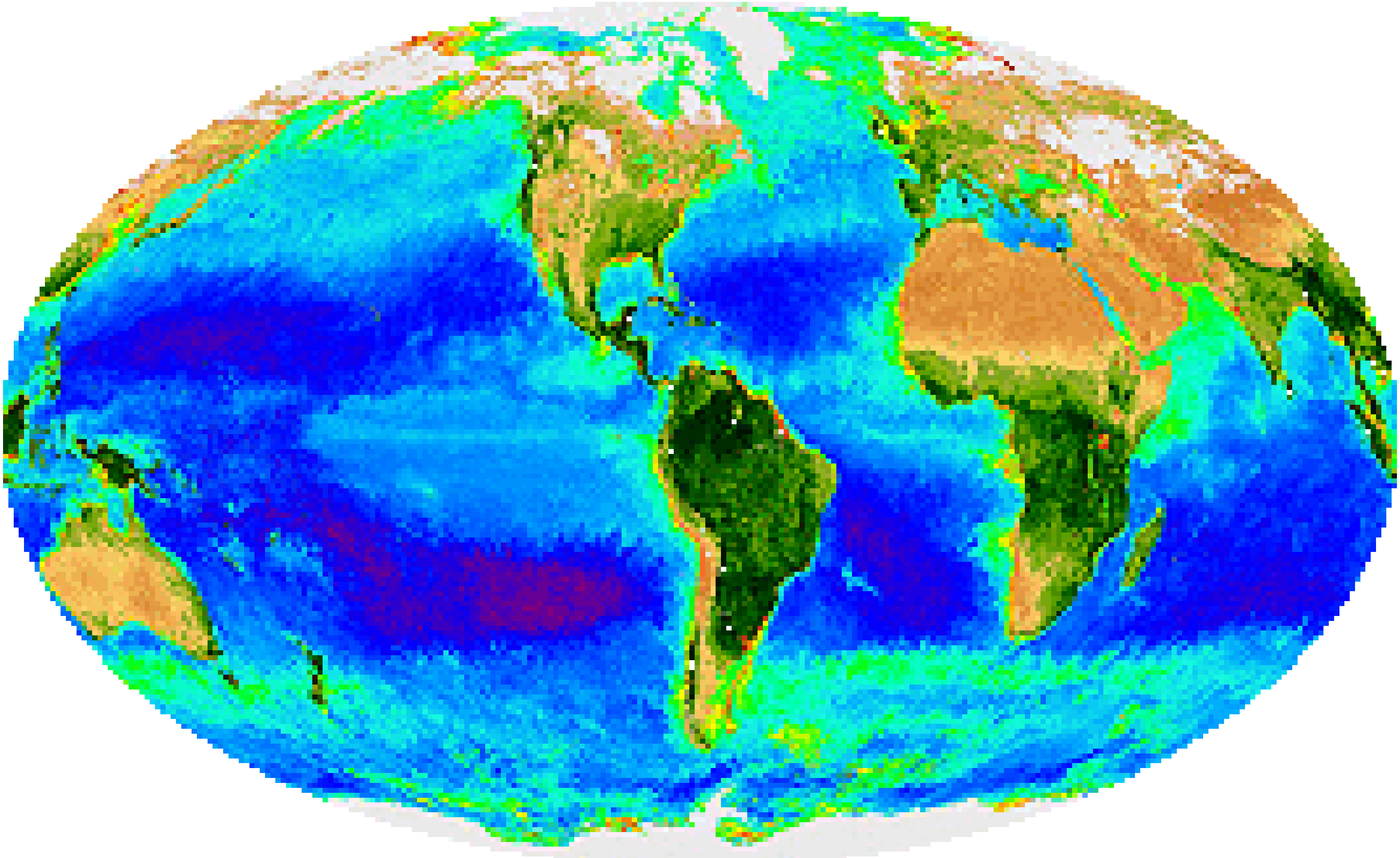

北京
中华人民共和国
我海军护航编队航线
三亚
索马里

国家海洋战略和利益


巴基斯坦瓜达尔港
孟加拉达卡港
缅甸实兑港
吉布提吉布提港
斯里兰卡汉班托特港
尼日利亚拉各斯港
柬埔寨西哈努克港
泰国兰达港
马尔代夫
肯尼亚蒙巴萨港
塞舌尔
坦桑尼亚达累斯萨拉姆港



Multi-platform
Long-term
observations




The 5th International Symposium on Remote Sensing of the Indian Ocean-South China Sea and Typhoon Sciences (IOSCS-Typhoon 2015)--International Cooperation in Research for the 21st Century Maritime Silk Road
21 世纪海上丝绸之路的海洋研究与国际合作—第 5 届印度洋 – 南海海洋遥感与台风科学国际研讨会
2015.8.25

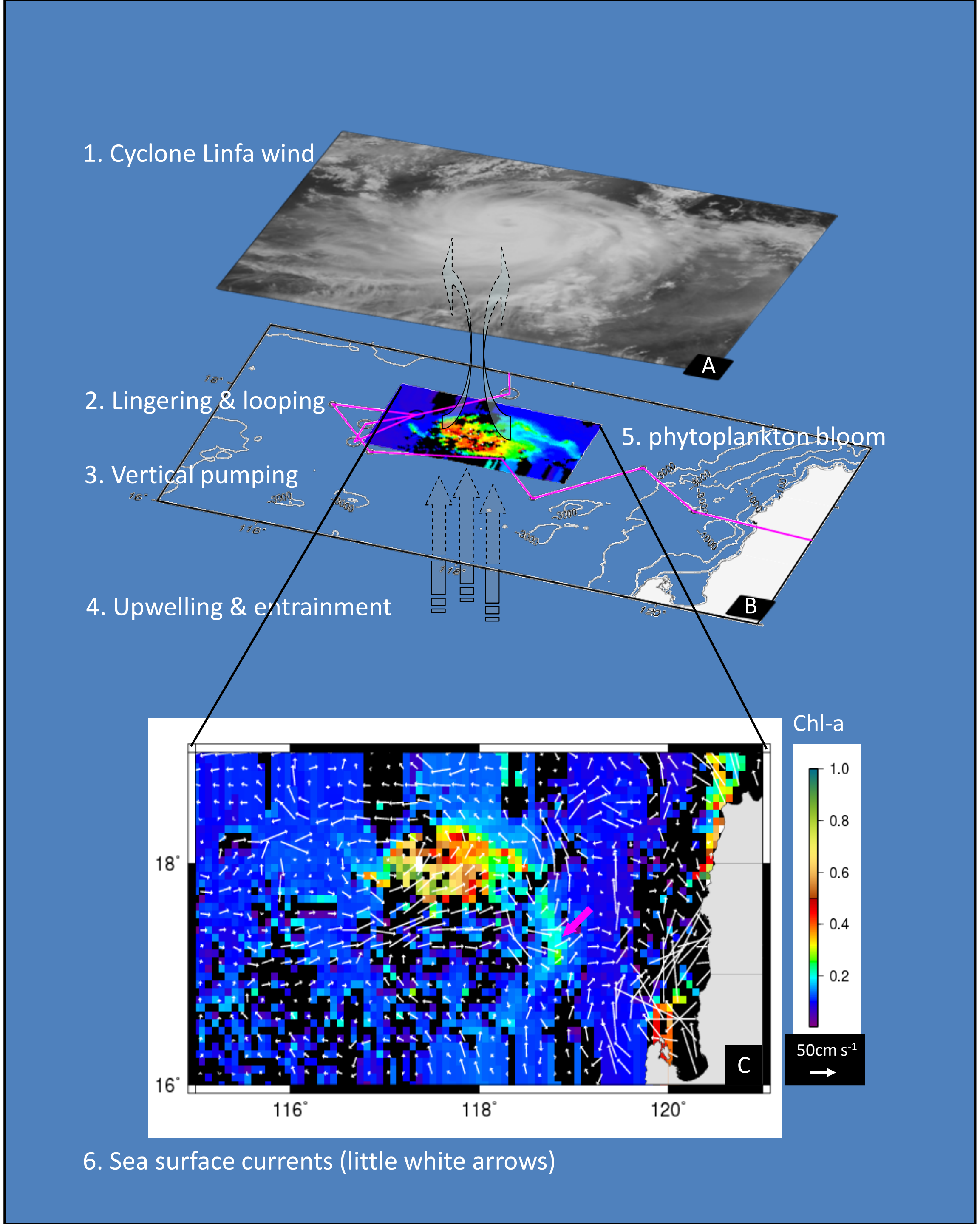
Remote Sensing of Maritime Silk Road Region -- Environments and Ecosystem

--- "Wind pump" and "Remote Sensing of Marine Ecology"

DanLing Tang

South China Sea Institute of Oceanology
Chinese Academy of Sciences

http://lingzis.51.net/ Lingzistdl@126.com

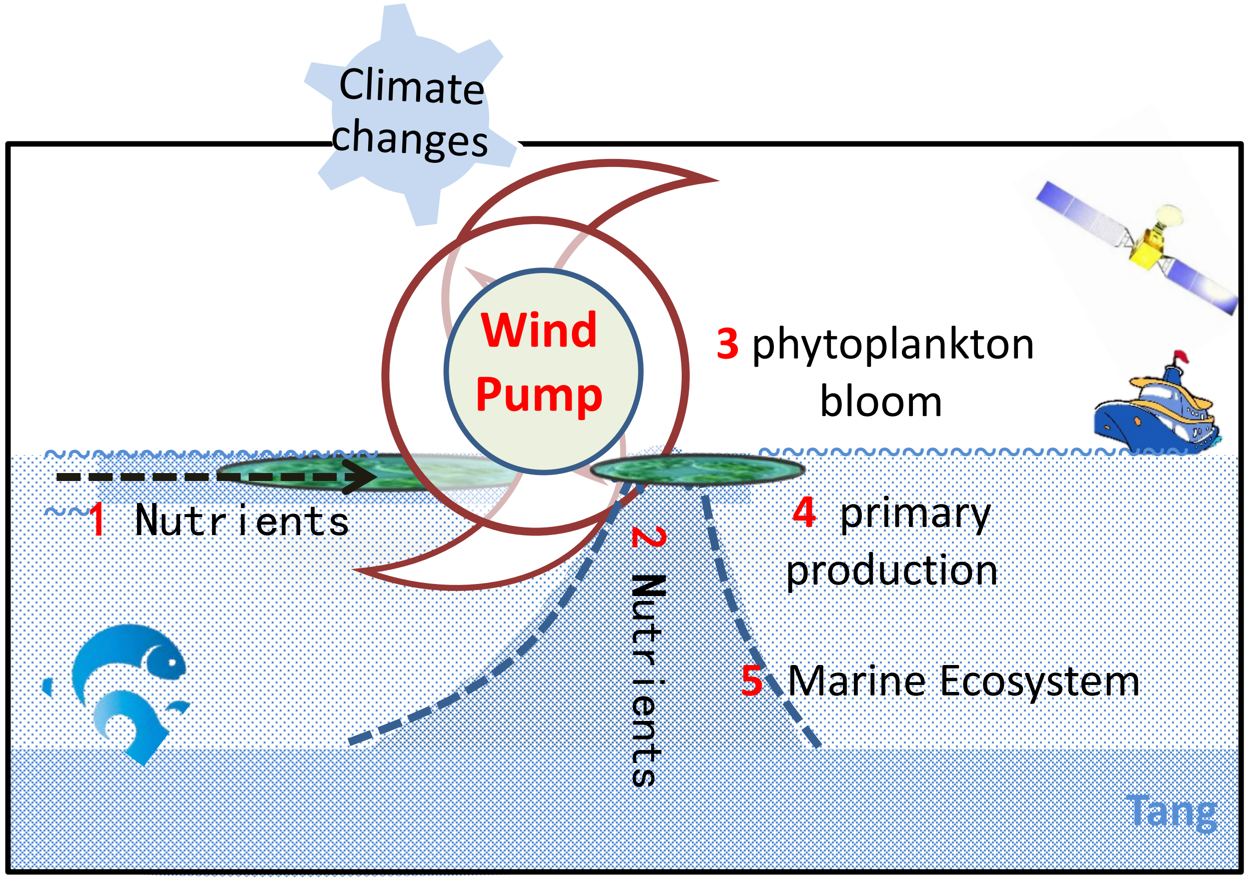


Yongqiang CHEN, DANLING TANG, 2012,

Eddy-feature phytoplankton bloom induced by tropical cyclone in the South China Sea,

International Journal of Remote Sensing. Vol. 33, No. 23, 10 December 2012, 7444–7457.（SCI）

Chen, Tang, 2011, IJRS



Climate – “Wind Pump” –

upwelling, mixing, nutrients redistribution – phytoplankton – primary production – marine ecosystem

International Think Tank Forum

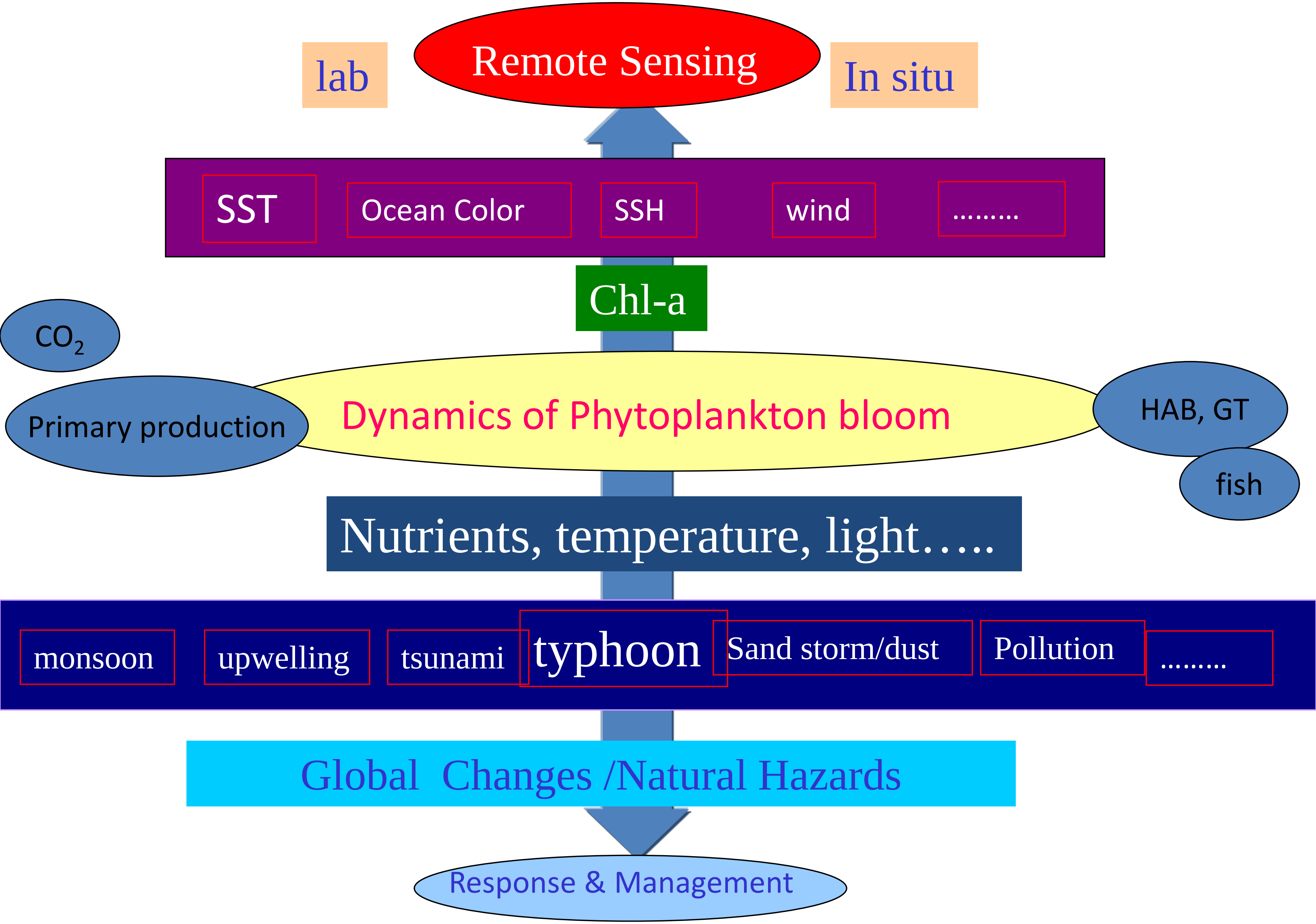
Marine Environmental Protection: Prospects and Challenges?

DanLing Tang 唐丹玲

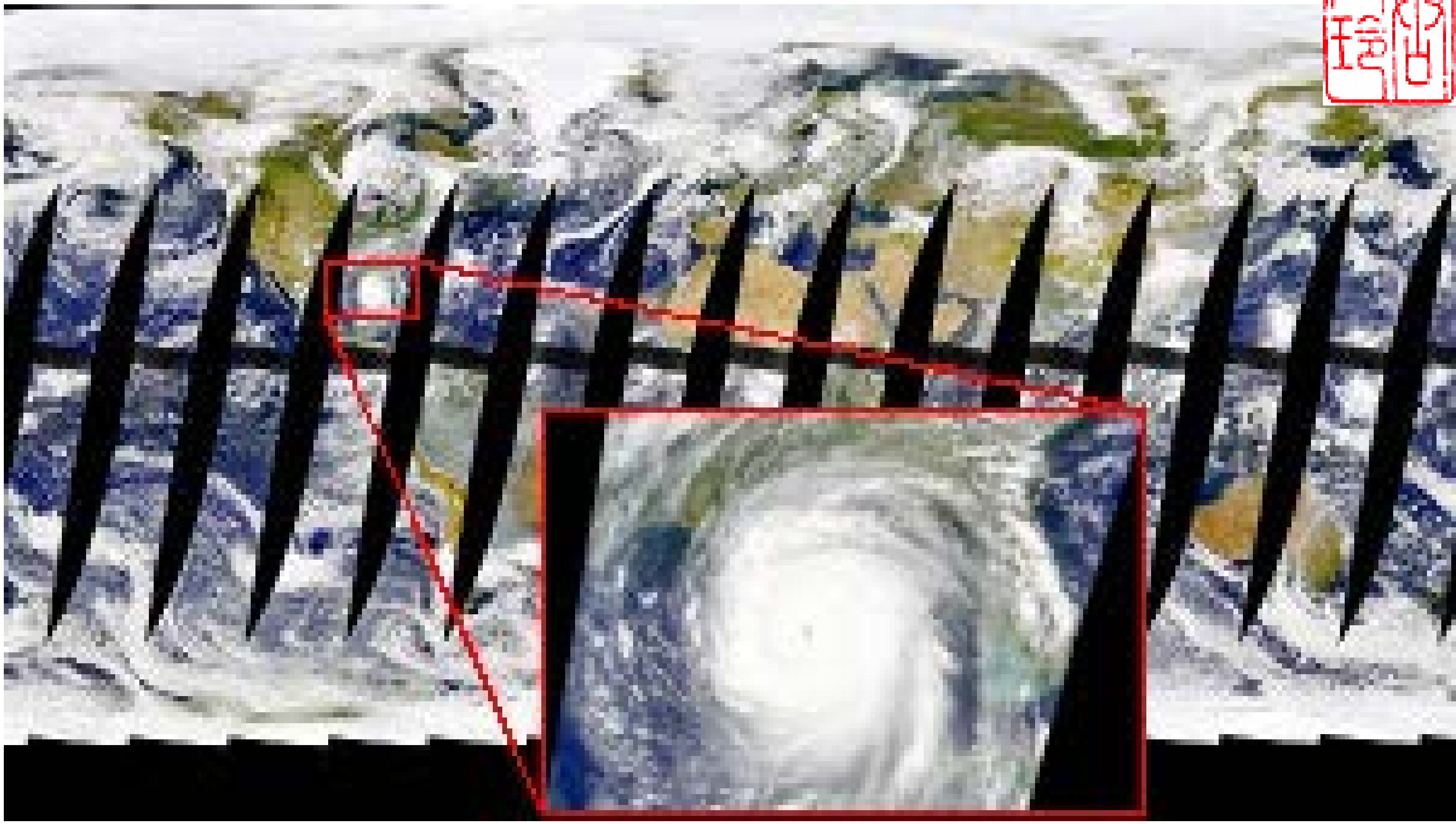
中国科学院 南海海洋研究所

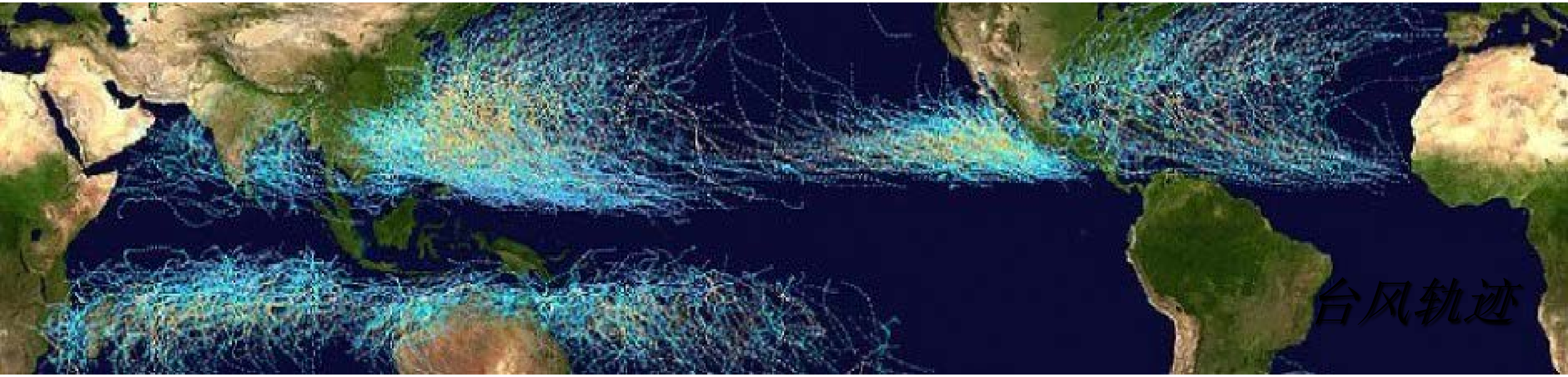
South China Sea Institute of Oceanology

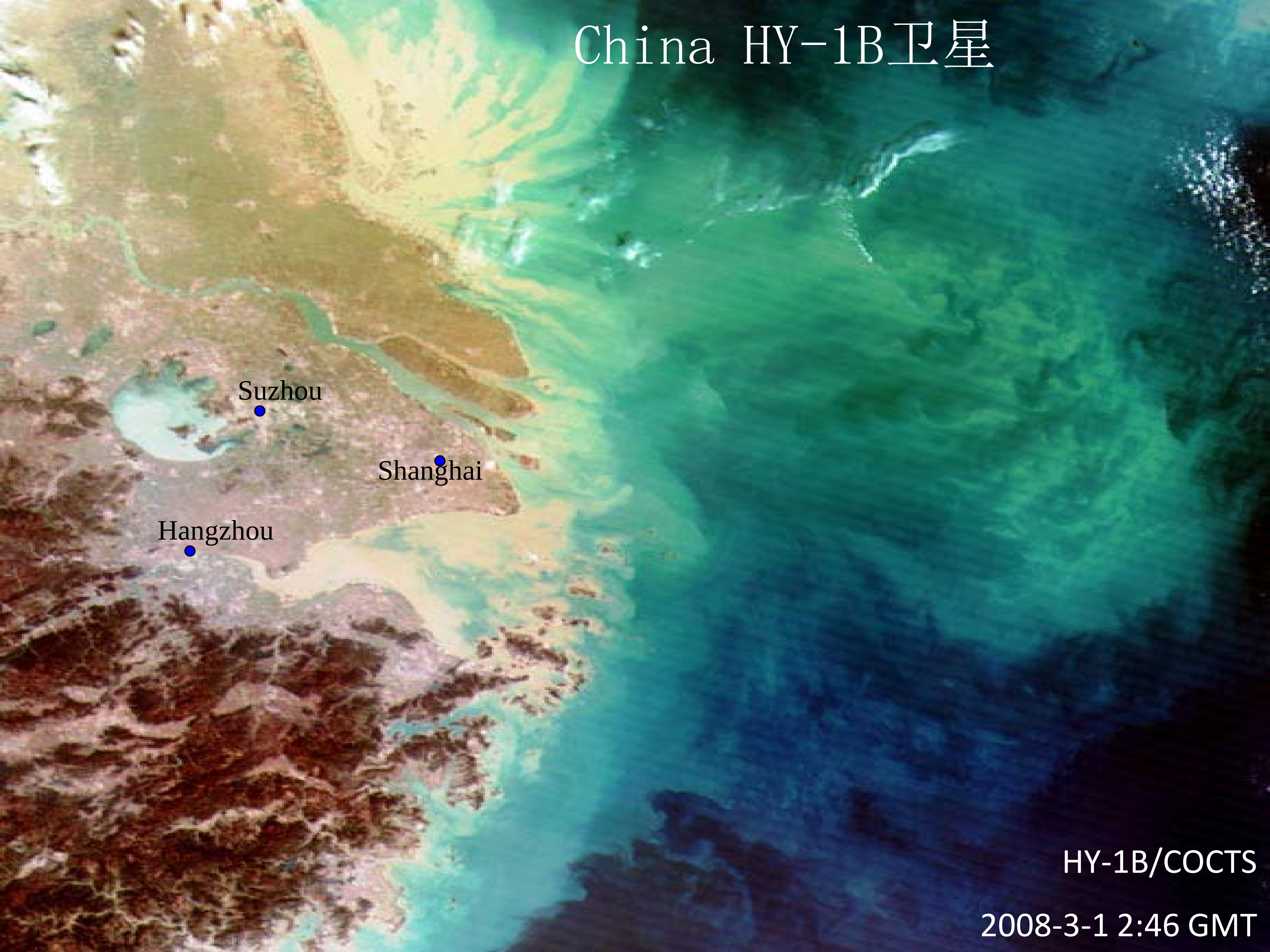
Chinese Academy of Sciences

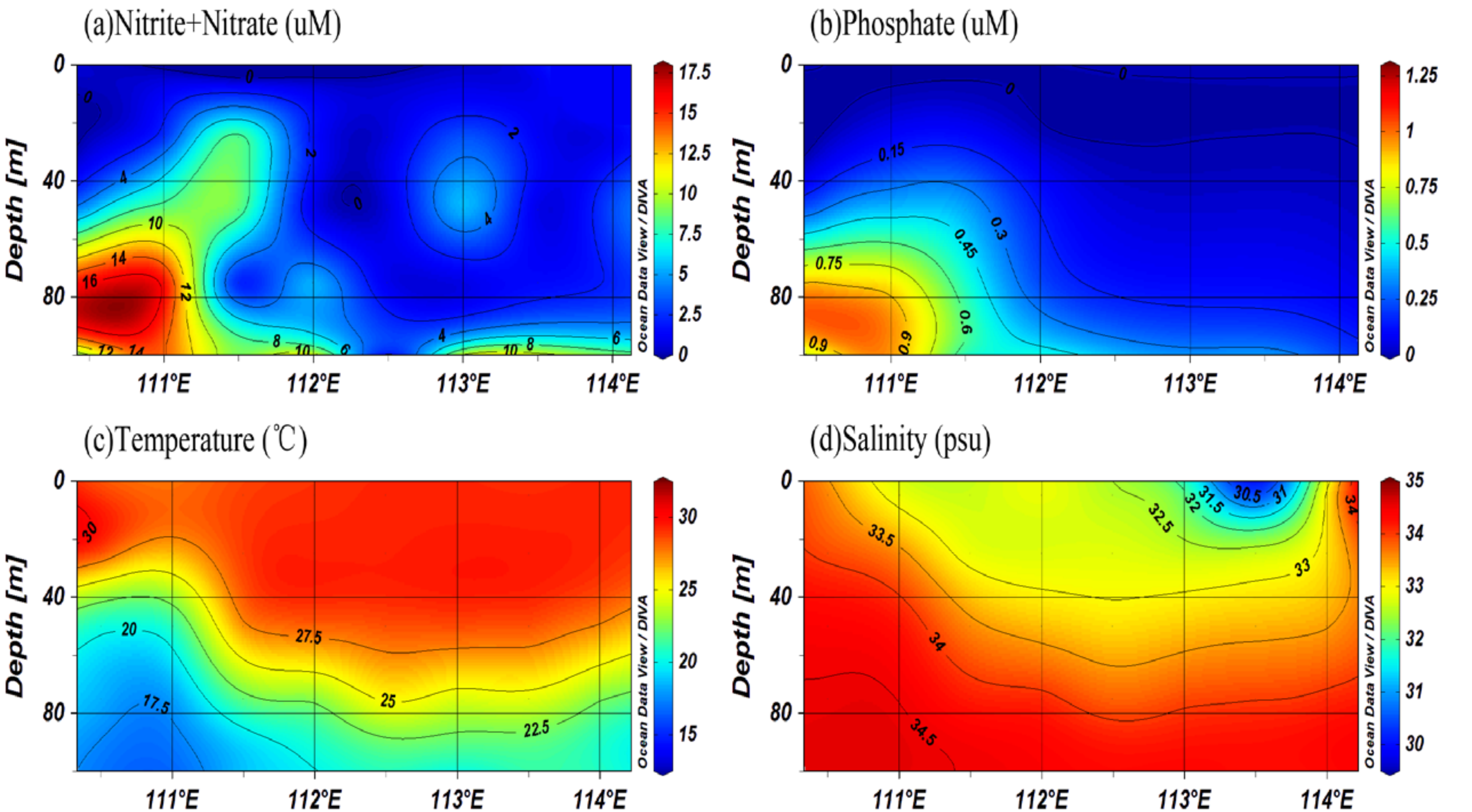

Remote Sensing
lab
In situ
SST
Ocean Color
SSH
wind
………
Chl-a
CO_2
Primary production
Dynamics of Phytoplankton bloom
HAB, GT
fish
Nutrients, temperature, light…..
monsoon
upwelling
tsunami
typhoon
Sand storm/dust
Pollution
………
Global Changes /Natural Hazards
Response & Management

Respirations

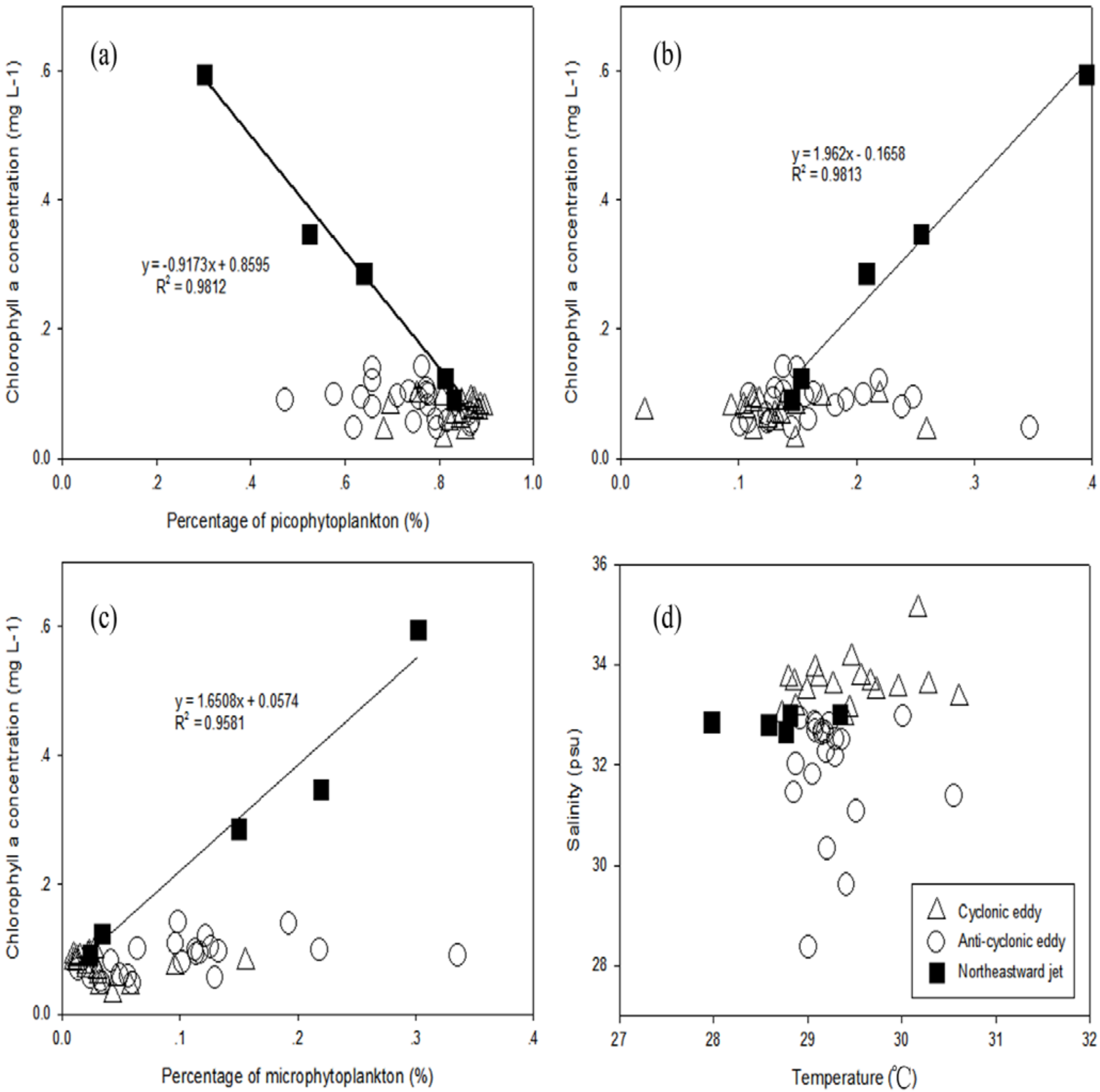





China HY-1B卫星
Suzhou
Shanghai
Hangzhou
HY-1B/COCTS
2008-3-1 2:46 GMT

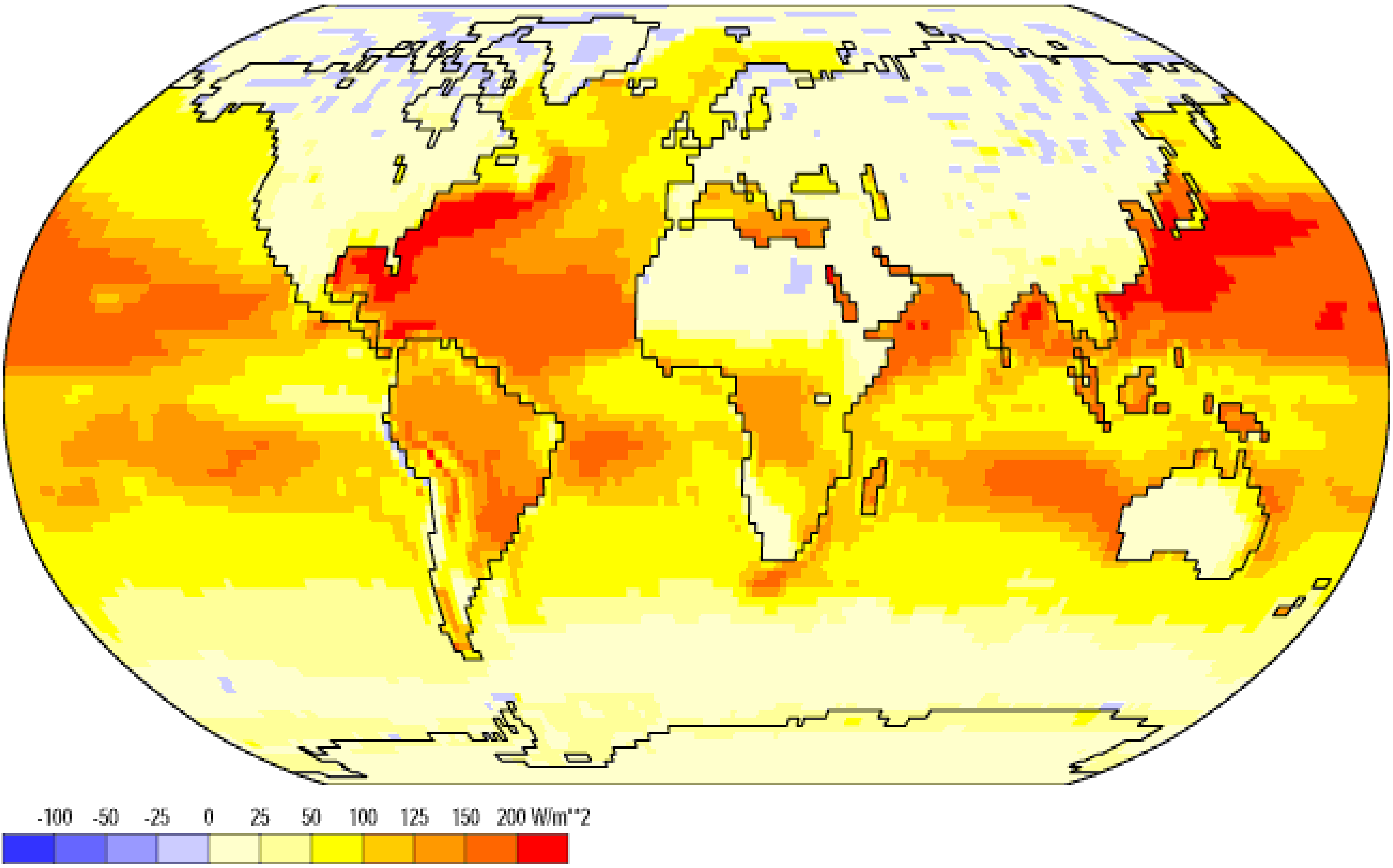


(a)Nitrite+Nitrate (uM)
(b)Phosphate (uM)
(c)Temperature (℃)
(d)Salinity (psu)
Depth [m]
111°E
112°E
113°E
114°E
Ocean Data View / DIVA



(a)
y = -0.9173x + 0.8595
R² = 0.9812
Chlorophyll a concentration (mg L-1)
Percentage of picophytoplankton (%)
(b)
y = 1.962x - 0.1658
R² = 0.9813
Chlorophyll a concentration (mg L-1)
(c)
y = 1.6508x + 0.0574
R² = 0.9581
Chlorophyll a concentration (mg L-1)
Percentage of microphytoplankton (%)
(d)
Salinity (psu)
Temperature (℃)
Cyclonic eddy
Anti-cyclonic eddy
Northeastward jet

Respirations



Data: NCEP/NCAR Reanalysis Project, 1959-1997 Climatologies
Animation: Department of Geography, University of Oregon, March 2000

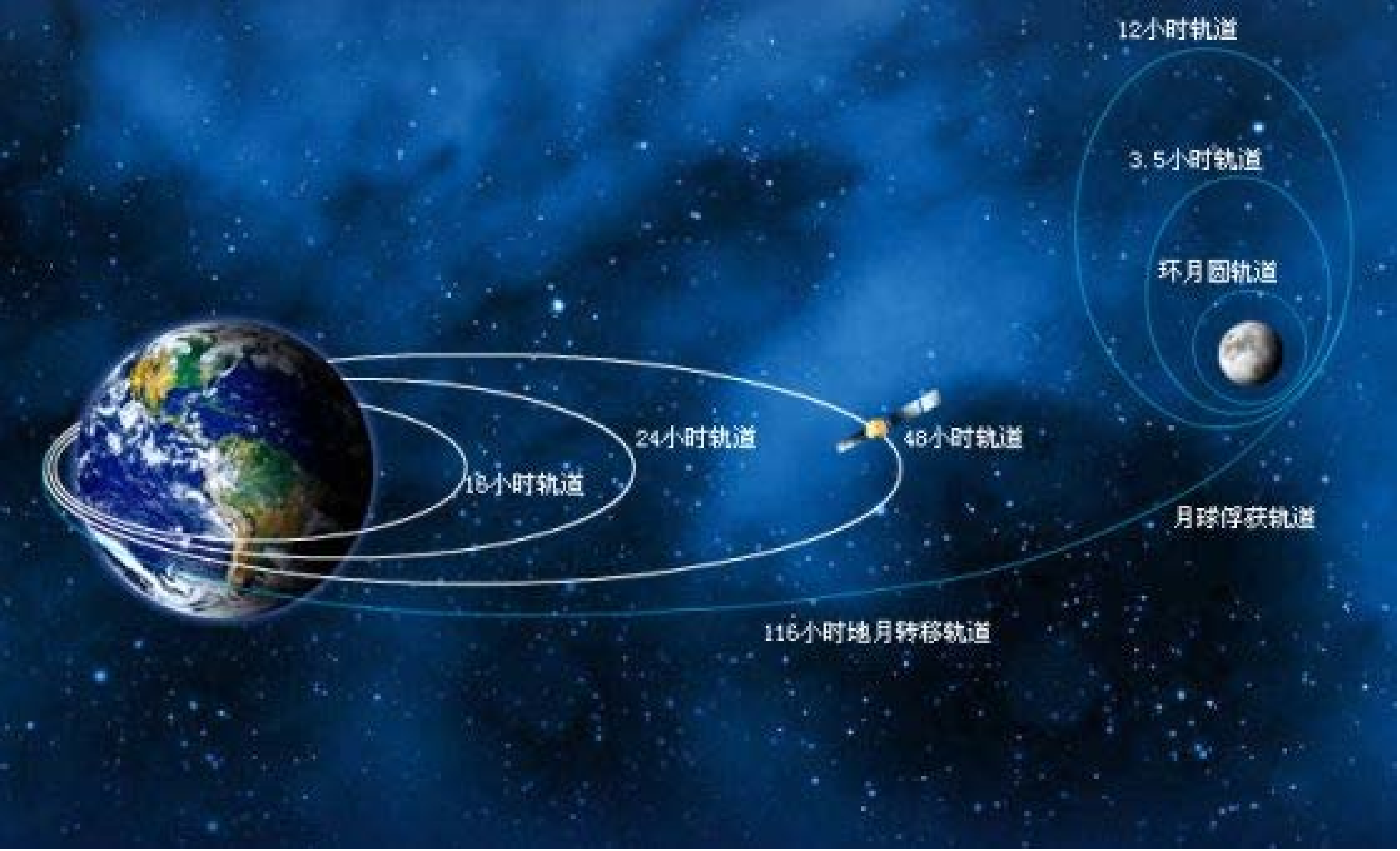
人造卫星中，间谍卫星高度最低，低的只有一百多公里，以便清晰地拍摄地面的照片，因为稀薄大气的阻力，所以寿命也不长；

高度较高的有同步静止卫星，高度在3.6万公里，

还有科学探测卫星，如我国发射的“双星”探测卫星，最远有8万多公里……

还有嫦娥1号等月球探测卫星，因为没有飞离地球系统，还是称为“卫星”，高度就有38万公里左右。

在卫星轨道高度达到35800千米，并沿地球赤道上空与地球自转同一方向飞行时，卫星绕地球旋转周期与地球自转周期完全相同，相对位置保持不变。此卫星在地球上看来是静止地挂在高空，称为地球静止轨道卫星，简称静止卫星


12小时轨道
3.5小时轨道
环月圆轨道
24小时轨道
48小时轨道
16小时轨道
月球俘获轨道
116小时地月转移轨道

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Fortaleza, Ceará, Brazil

25th PACON

March， 2017,
Zhoushang， China

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SOUTH CHINA SEA INSTITUTE OF OCEANOLOGY CHINESE ACADEMY O

Sciences

2015年，Science publish 5 papers

OCEAN PLANKTON

Structure and function of the global ocean microbiome

Shinichi Sunagawa,[1*†] Luis Pedro Coelho,[1*] Samuel Chaffron,[2,3,4*] Jens Roat Kultima,[1] Karine Labadie,[5] Guillem Salazar,[6] Bardya Djahanschiri,[1] Georg Zeller,[1] Daniel R. Mende,[1] Adriana Alberti,[5] Francisco M. Cornejo-Castillo,[6] Paul I. Costea,[1] Corinne Cruaud,[5] Francesco d'Ovidio,[7] Stefan Engelen,[5] Isabel Ferrera,[6] Josep M. Gasol,[6] Lionel Guidi,[8,9] Falk Hildebrand,[1] Florian Kokoszka,[10,11] Cyrille Lepoivre,[12] Gipsi Lima-Mendez,[2,3,4] Julie Poulain,[5] Bonnie T. Poulos,[13] Marta Royo-Llonch,[6] Hugo Sarmento,[6,14] Sara Vieira-Silva,[2,3,4] Céline Dimier,[10,15,16] Marc Picheral,[8,9] Sarah Searson,[8,9] Stefanie Kandels-Lewis,[1,17] *Tara* Oceans coordinators‡ Chris Bowler,[10] Colomban de Vargas,[15,16] Gabriel Gorsky,[8,9] Nigel Grimsley,[18,19] Pascal Hingamp,[12] Daniele Iudicone,[20] Olivier Jaillon,[5,21,22] Fabrice Not,[15,16] Hiroyuki Ogata,[23] Stephane Pesant,[24,25] Sabrina Speich,[26,27] Lars Stemmann,[8,9] Matthew B. Sullivan,[13] Jean Weissenbach,[5,21,22] Patrick Wincker,[5,21,22] Eric Karsenti,[10,17†] Jeroen Raes,[2,3,4†] Silvia G. Acinas,[6†] Peer Bork[1,28†]

Tara Oceans studies plankton at PLANETARY SCALE

By P. Bork,[1] C. Bowler,[2] C. de Vargas,[3,4] G. Gorsky,[5,6] E. Karsenti,[2,7] P. Wincker[8]

OCEAN PLANKTON

Determinants of community structure in the global plankton interactome

Gipsi Lima-Mendez,[1,2,3*] Karoline Faust,[1,2,3*] Nicolas Henry,[4,5*] Johan Decelle,[4,5] Sébastien Colin,[4,5,6] Fabrizio Carcillo,[1,2,3,7] Samuel Chaffron,[1,2,3] J. Cesar Ignacio-Espinosa,[8†] Simon Roux,[8†] Flora Vincent,[2,6] Lucie Bittner,[4,5,6,9] Youssef Darzi,[2,3] Jun Wang,[1,2] Stéphane Audic,[4,5] Léo Berline,[10,11] Gianluca Bontempi,[7] Ana M. Cabello,[12] Laurent Coppola,[10,11] Francisco M. Cornejo-Castillo,[12] Francesco d'Ovidio,[13] Luc De Meester,[14] Isabel Ferrera,[12] Marie-José Garet-Delmas,[4,5] Lionel Guidi,[10,11] Elena Lara,[12] Stéphane Pesant,[15,16] Marta Royo-Llonch,[12] Guillem Salazar,[12] Pablo Sánchez,[12] Marta Sebastian,[12] Caroline Souffreau,[14] Céline Dimier,[4,5,6] Marc Picheral,[10,11] Sarah Searson,[10,11] Stefanie Kandels-Lewis,[17,18] Tara Oceans coordinators‡ Gabriel Gorsky,[10,11] Fabrice Not,[4,5] Hiroyuki Ogata,[19] Sabrina Speich,[20,21] Lars Stemmann,[10,11] Jean Weissenbach,[22,23,24] Patrick Wincker,[22,23,24] Silvia G. Acinas,[12] Shinichi Sunagawa,[17] Peer Bork,[17,25] Matthew B. Sullivan,[8†] Eric Karsenti,[6,18§] Chris Bowler,[6§] Colomban de Vargas,[4,5§] Jeroen Raes[1,2,3§]

OCEAN PLANKTON

Environmental characteristics of Agulhas rings affect interocean plankton transport

Emilie Villar,[1*] Gregory K. Farrant,[2,3†] Michael Follows,[11†] Laurence Garczarek,[2,3†] Sabrina Speich,[5,23¶] Stéphane Audic,[2,3] Lucie Bittner,[2,3,4‡] Bruno Blanke,[5] Jennifer R. Brum,[6**] Christophe Brunet,[7] Raffaella Casotti,[7] Alison Chase,[8] John R. Dolan,[9,10] Fabrizio d'Ortenzio,[9,10] Jean-Pierre Gattuso,[9,10] Nicolas Grima,[5] Lionel Guidi,[9,10] Christopher N. Hill,[11] Oliver Jahn,[11] Jean-Louis Jamet,[12] Hervé Le Goff,[13] Cyrille Lepoivre,[1] Shruti Malviya,[4] Eric Pelletier,[14,15,16] Jean-Baptiste Romagnan,[9,10] Simon Roux,[6**] Sébastien Santini,[1] Eleonora Scalco,[7] Sarah M. Schwenck,[6] Atsuko Tanaka,[4§] Pierre Testor,[13] Thomas Vannier,[14,15,16] Flora Vincent,[4] Adriana Zingone,[7] Céline Dimier,[2,3,4] Marc Picheral,[9,10] Sarah Searson,[9,10||] Stefanie Kandels-Lewis,[17,18] *Tara* Oceans Coordinators¶ Silvia G. Acinas,[19] Peer Bork,[17,20] Emmanuel Boss,[8] Colomban de Vargas,[2,3] Gabriel Gorsky,[9,10] Hiroyuki Ogata,[1#] Stéphane Pesant,[21,22] Matthew B. Sullivan,[6**] Shinichi Sunagawa,[17] Patrick Wincker,[14,15,16] Eric Karsenti,[4,18*] Chris Bowler,[4*] Fabrice Not,[2,3*††] Pascal Hingamp,[1*††] Daniele Iudicone[7*††]

OCEAN PLANKTON

Eukaryotic plankton diversity in the sunlit ocean

Colomban de Vargas,[1,2*†] Stéphane Audic,[1,2†] Nicolas Henry,[1,2†] Johan Decelle,[1,2†] Frédéric Mahé,[3,1,2†] Ramiro Logares,[4] Enrique Lara,[5] Cédric Berney,[1,2] Noan Le Bescot,[1,2] Ian Probert,[6,7] Margaux Carmichael,[1,2,8] Julie Poulain,[9] Sarah Romac,[1,2] Sébastien Colin,[1,2,8] Jean-Marc Aury,[9] Lucie Bittner,[10,11,8,1,2] Samuel Chaffron,[12,13,14] Micah Dunthorn,[3] Stefan Engelen,[9] Olga Flegontova,[15,16] Lionel Guidi,[17,18] Aleš Horák,[15,16] Olivier Jaillon,[9,19,20] Gipsi Lima-Mendez,[12,13,14] Julius Lukeš,[15,16,21] Shruti Malviya,[8] Raphael Morard,[22,1,2] Matthieu Mulot,[5] Eleonora Scalco,[23] Raffaele Siano,[24] Flora Vincent,[13,8] Adriana Zingone,[23] Céline Dimier,[1,2,8] Marc Picheral,[17,18] Sarah Searson,[17,18] Stefanie Kandels-Lewis,[25,26] *Tara* Oceans Coordinators† Silvia G. Acinas,[4] Peer Bork,[25,27] Chris Bowler,[8] Gabriel Gorsky,[17,18] Nigel Grimsley,[28,29] Pascal Hingamp,[30] Daniele Iudicone,[23] Fabrice Not,[1,2] Hiroyuki Ogata,[31] Stephane Pesant,[32,22] Jeroen Raes,[12,13,14] Michael E. Sieracki,[33,34] Sabrina Speich,[35,36] Lars Stemmann,[17,18] Shinichi Sunagawa,[25] Jean Weissenbach,[9,19,20] Patrick Wincker,[9,19,20*] Eric Karsenti[26,8*]

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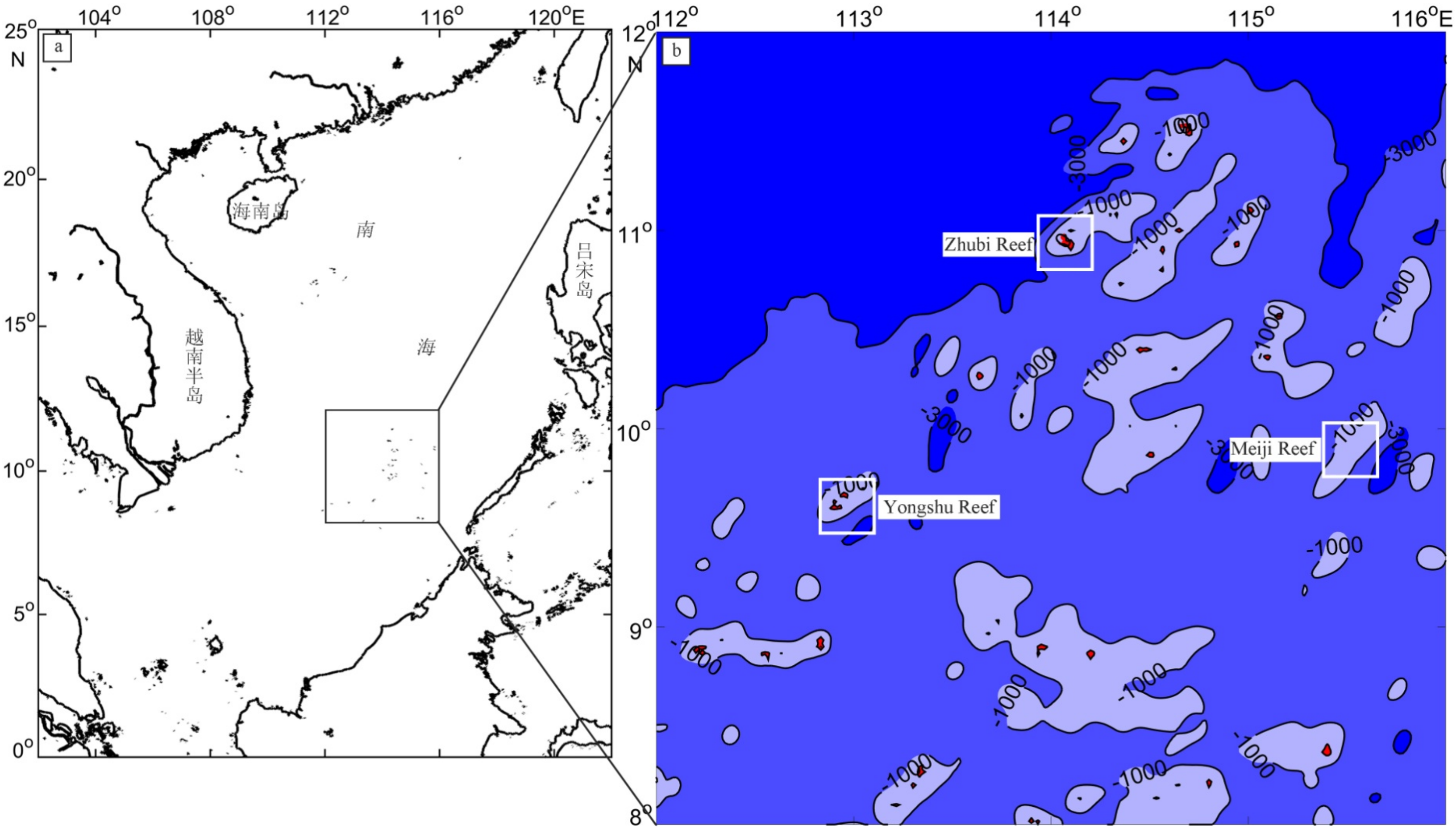
Resurrecting the Ecological Underpinnings of Ocean Plankton Blooms

Michael J. Behrenfeld[1] and Emmanuel S. Boss[2]

南海的科学问题

- 1. 热带海洋环境特征与生态系统
  - 高温、温跃层 、寡营养、
  - 营养盐的输运与·生物的基础生产过程
- 2.人类活动的影响
  - 岛礁、填礁、运输、溢油
- 3. 社会、国家（资源）
  - 海疆国界
  - 一带一路



a. 南海位置；b. 南沙群岛地形

Fig.1 Topography of SCS and Nansha Islands

a. location of SCS; b. topography of Nansha Islands

Tab.1 Information of remote sensors

卫星传感器	波段数	波段范围/μm	分辨率/m
(Landsat1-5)MSS	4	0.5-1.1	80
(Landsat3-57)TM	7	0.45-2.35	30(除热红外和全色波段)
(Landsat57)ETM	8	0.45-2.35	
(Lansat8)OLI	9	0.433-2.3	
AVHRR	5	0.55-12.5	1100
SeaWiFS	8	0.402-0.885	1100
MODIS	36	0.402-14.385	250,500,1000
CZCS	6	0.443-1.15	825
MERIS	15		1200
COCTS	10	0.402-12.5	1100

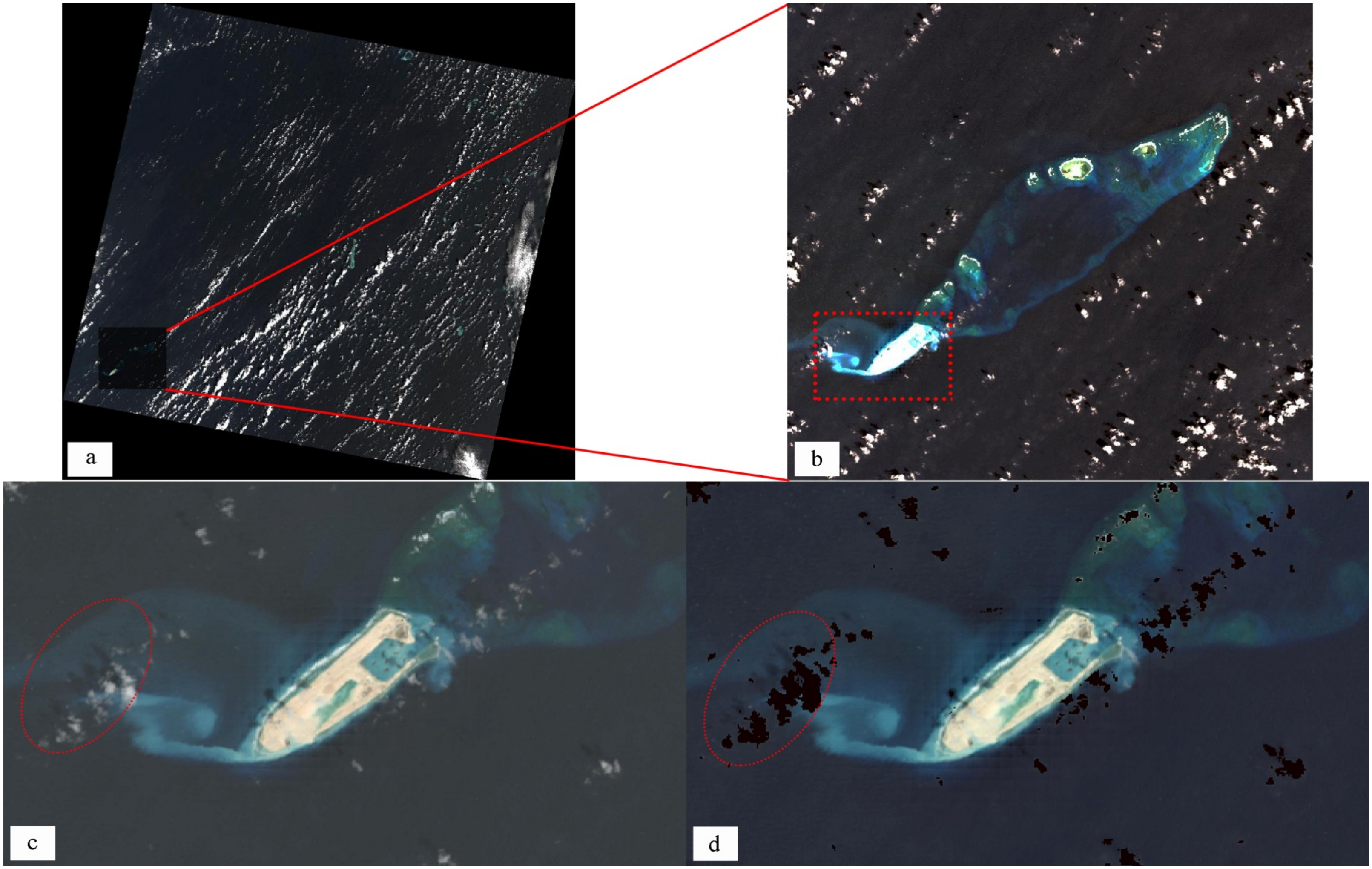
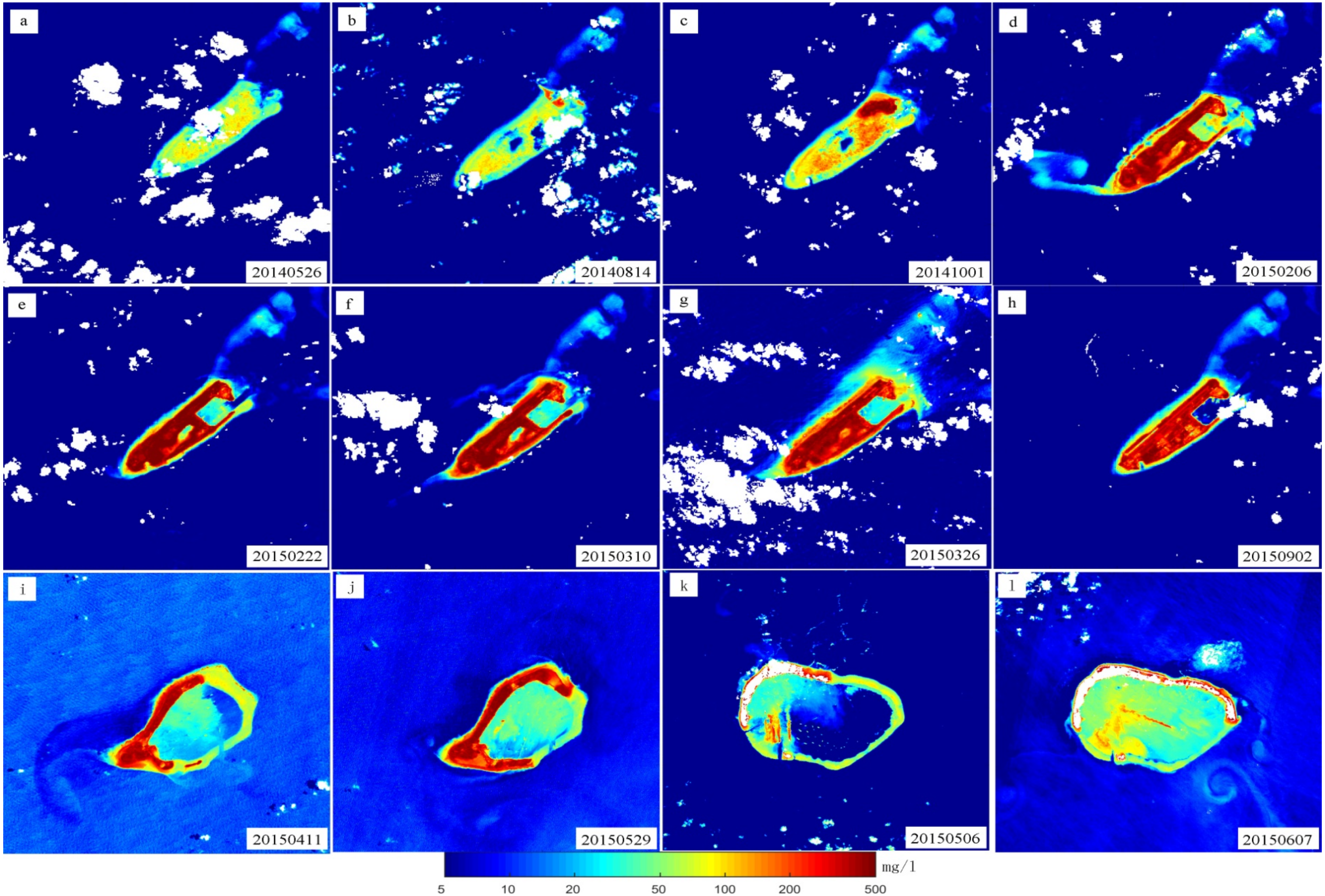


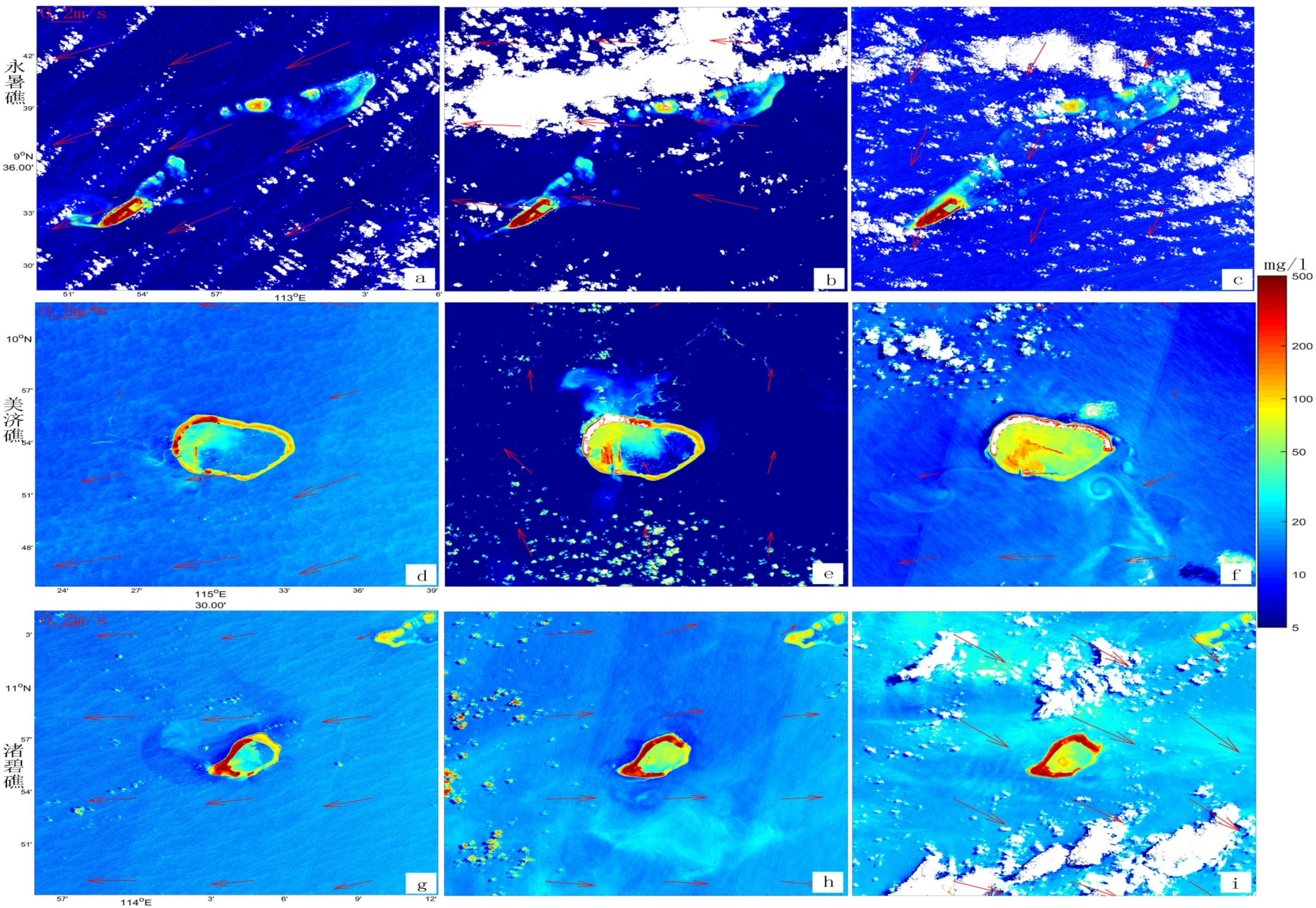
Fig.2 Image process of Landsat 8 OLI in Feb. 7th, 2015

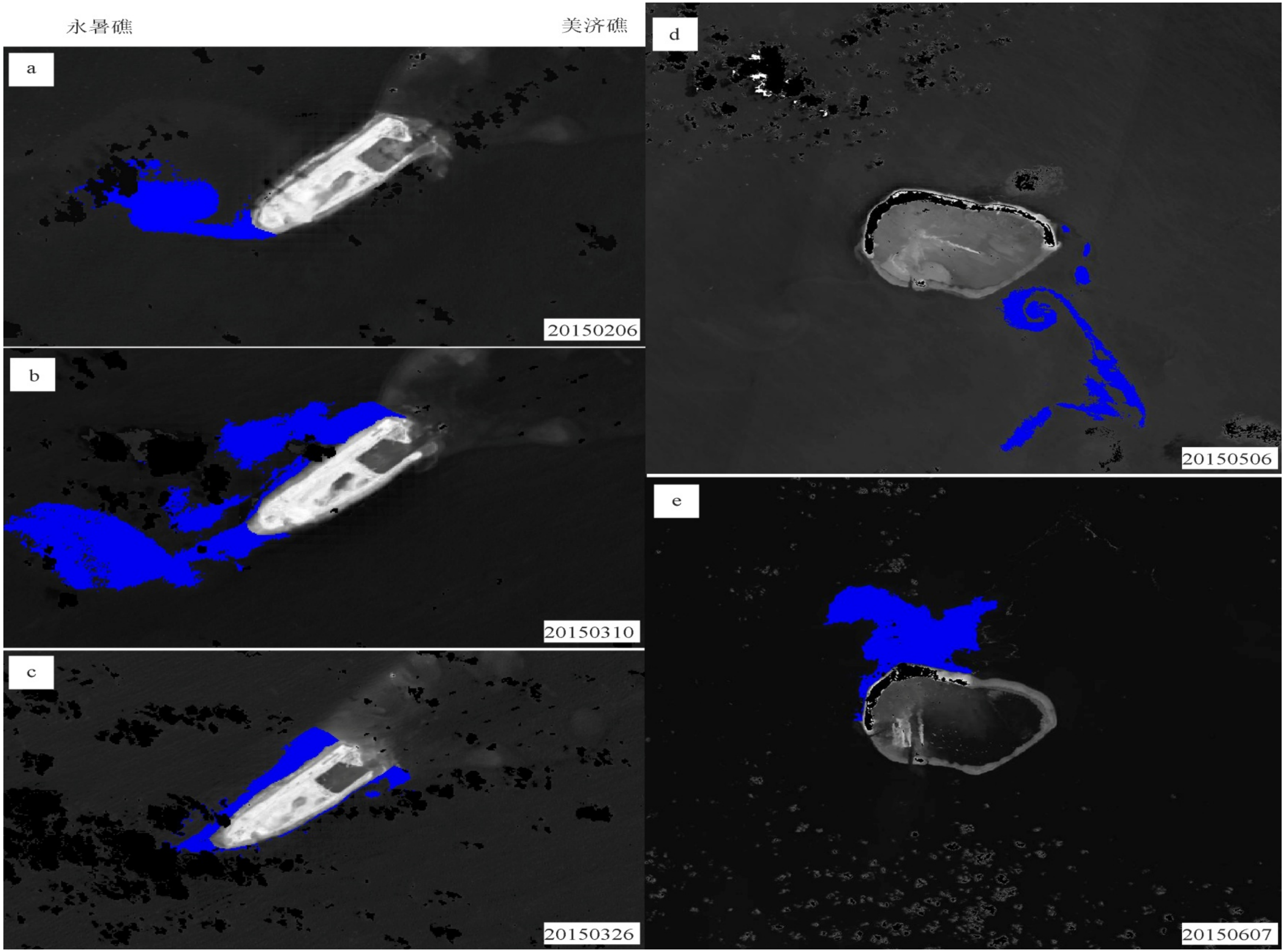
a. Original true color image, b. zoom image of Yongshu Reef, c. partial image after cutting of Yongshu Reef, d. after radiation correction , atmospheric correction and cloud removing



SS distribution in the surrounding water from May, 2014 to Sep., 2015,

Yongshu Reef, Zhubi Reef, Meiji Reef （永暑礁，渚碧礁，美济礁）

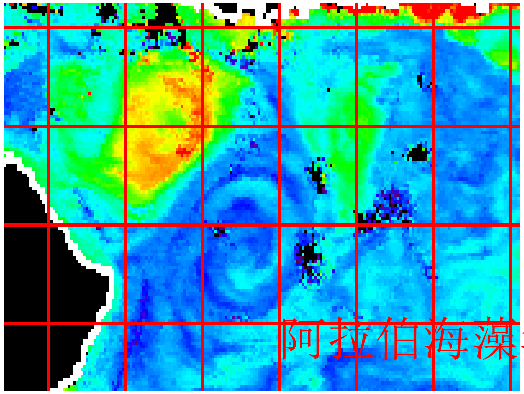

0.2m/s
永暑礁
42'
39'
9°N
36.00'
33'
30'
51'
54'
57'
113°E
3'
6'
a
b
c
美济礁
10°N
57'
54'
51'
48'
24'
27'
115°E
30.00'
33'
36'
39'
d
e
f
渚碧礁
3'
11°N
57'
54'
51'
57'
114°E
3'
6'
9'
12'
g
h
i
mg/l
500
200
100
50
20
10
5



Sphere of SS distribution in Yongshu Reef (a, b ,c) and Meiji Reef(d, e) during islands and reefs building period

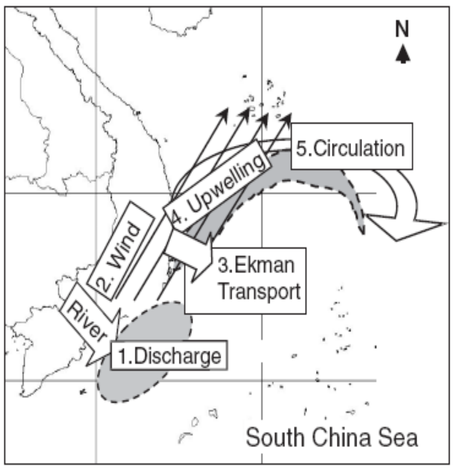
1. Introduction:
2. Wind induced phytoplankton bloom
3. Typhoon impact on Marine Ecosystem
4. Remote Sensing of Marine Ecosystem

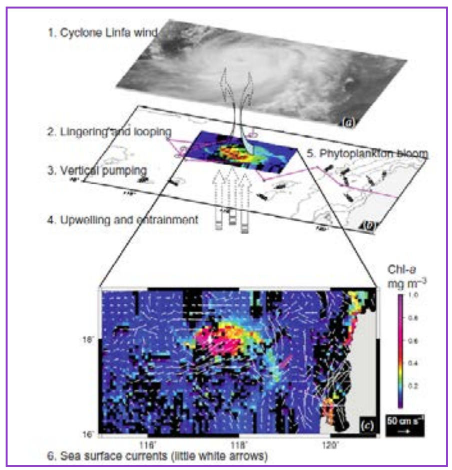
Climate Changes / Natural Hazards

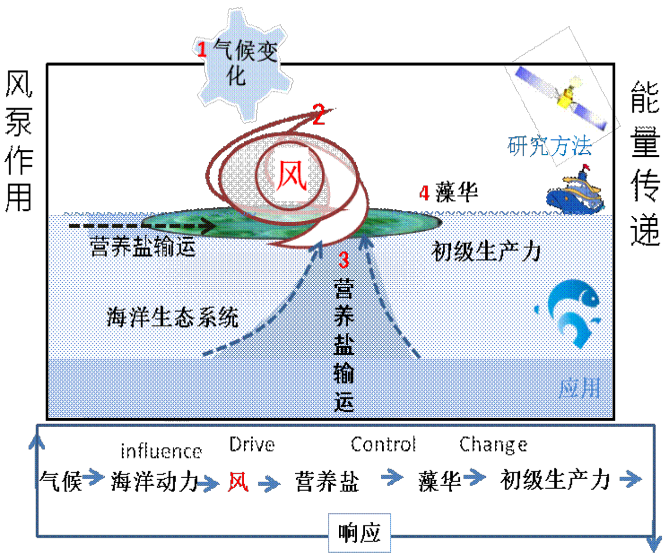


研究基础

（1）提出了“海洋藻华的风泵调控机理”







原创性：是对半个多世纪以来的两个经典的藻华形成理论“临界深度理论”和“富营养化”的重要补充。

推动了海洋生态遥感学科的发展