United Nations/Austria Symposium

Integrated Space Technology Applications for Climate Change

Remote Sensing of effects of Climate Changes on Coastal and Marine Ecosystems

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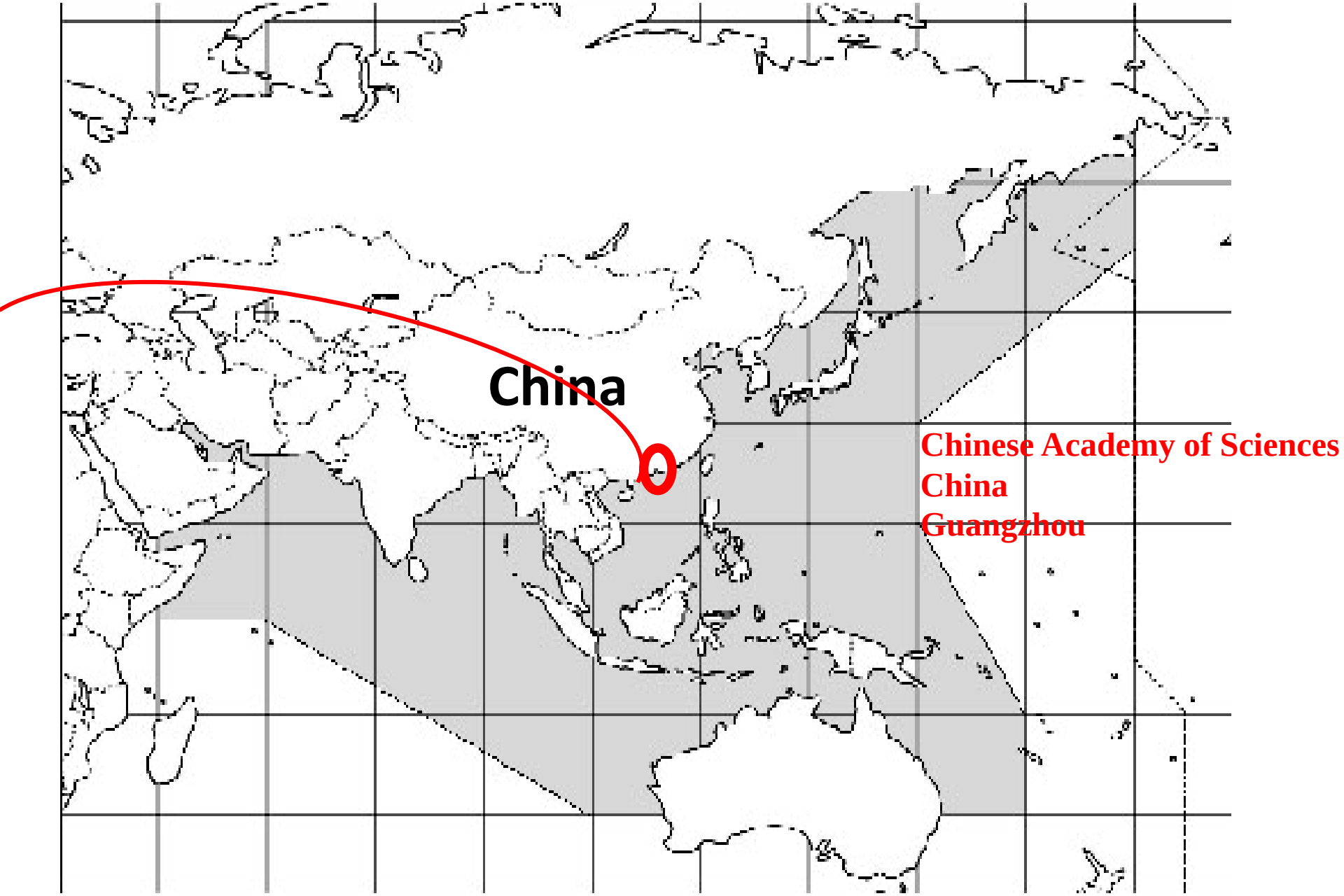
South China Sea Institute of Oceanology
Chinese Academy of Sciences

Tang DanLing 唐丹玲



1 Introduction: Climate change

2 Climate Change impact on Coastal Environments

3 Typhoon impact on Marine Ecosystem

4 Remote Sensing of Marine Ecosystem

中科院南海海洋研究所 唐丹玲

1 Introduction

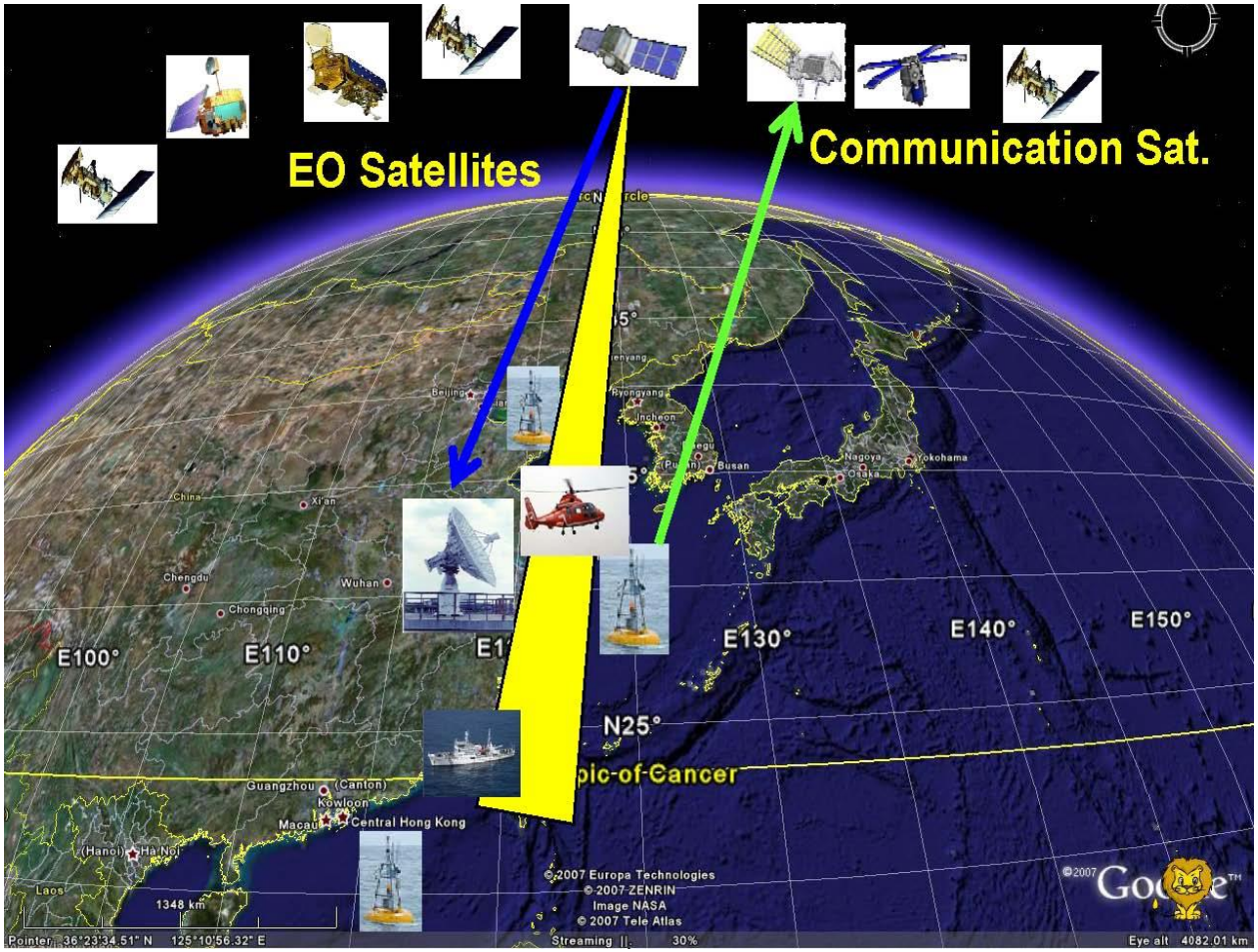
Climate change has been recognized as a major challenge that needs to be addressed globally

In 1966, the World Meteorological Organization (WMO) proposed the term **climatic change** to encompass all forms of climatic variability on time-scales longer than 10 years, whether the cause was natural or anthropogenic

When it was realized that **human activities** had a potential to drastically alter the climate, the term climate change replaced **climatic change** as the dominant term to reflect an **anthropogenic cause**.

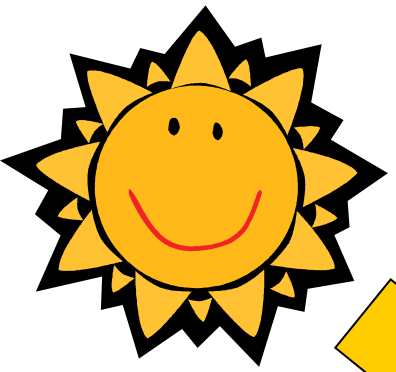
Climate change, used as a noun, became an issue rather than the technical description of changing weather.[6]

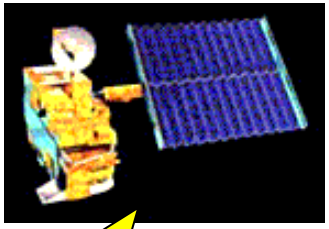
Satellite Remote Sensing



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。

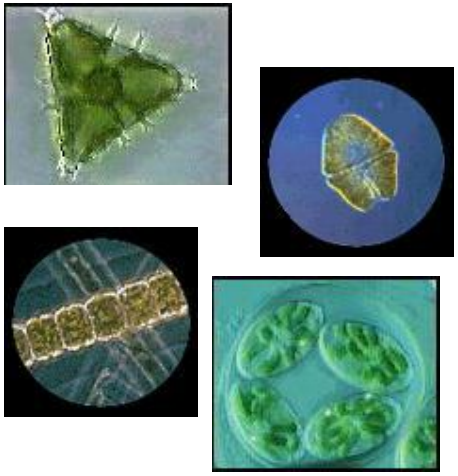
Ocean Color Remote Sensing





阳光

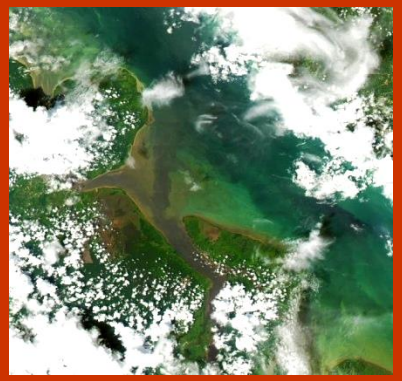
离水辐射



Phytoplankton

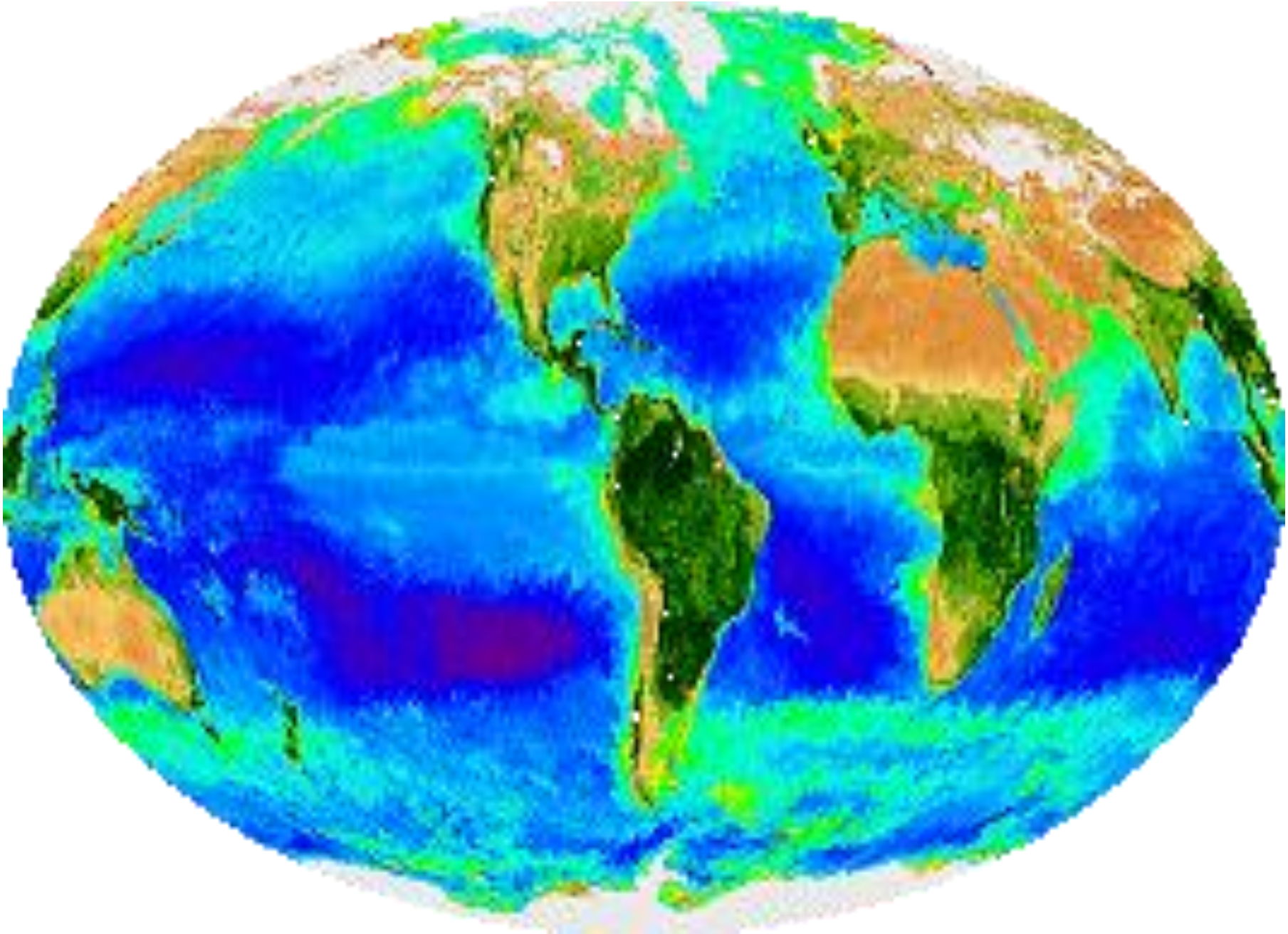
Ocean

悬浮沉积物



DOC

Marine Primary Production



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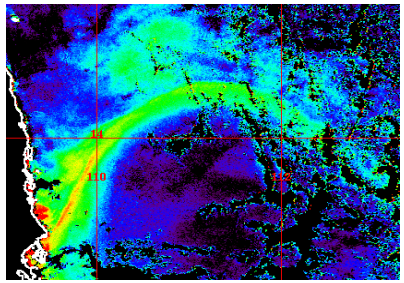
2 Climate Change

_ Coastal Environments

Phytoplankton

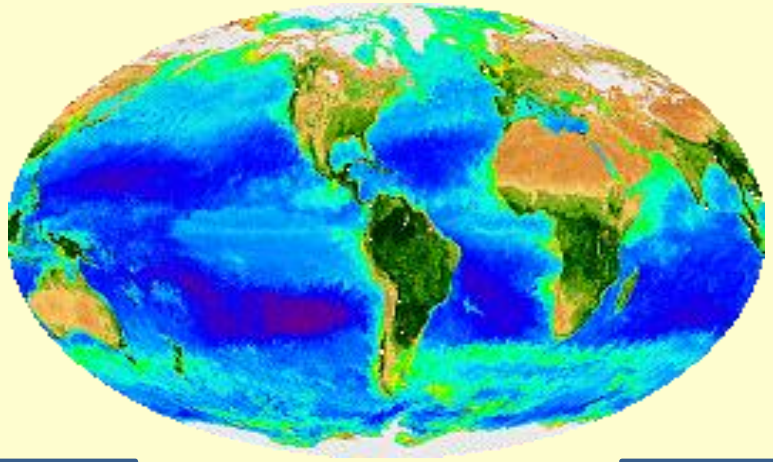
提供

Primary Production



生物资源

Bloom



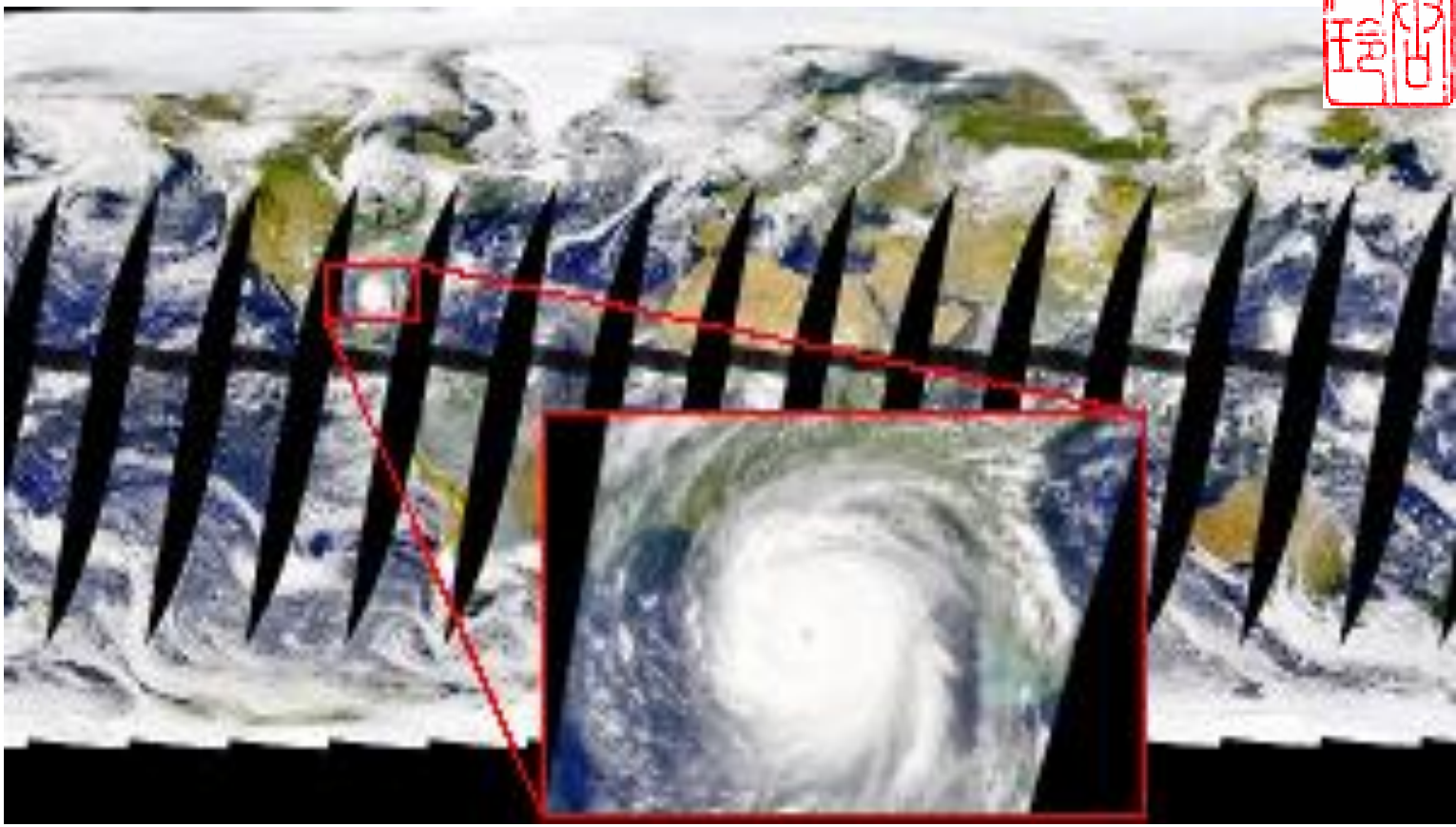
参与能量传递
生源要素循环

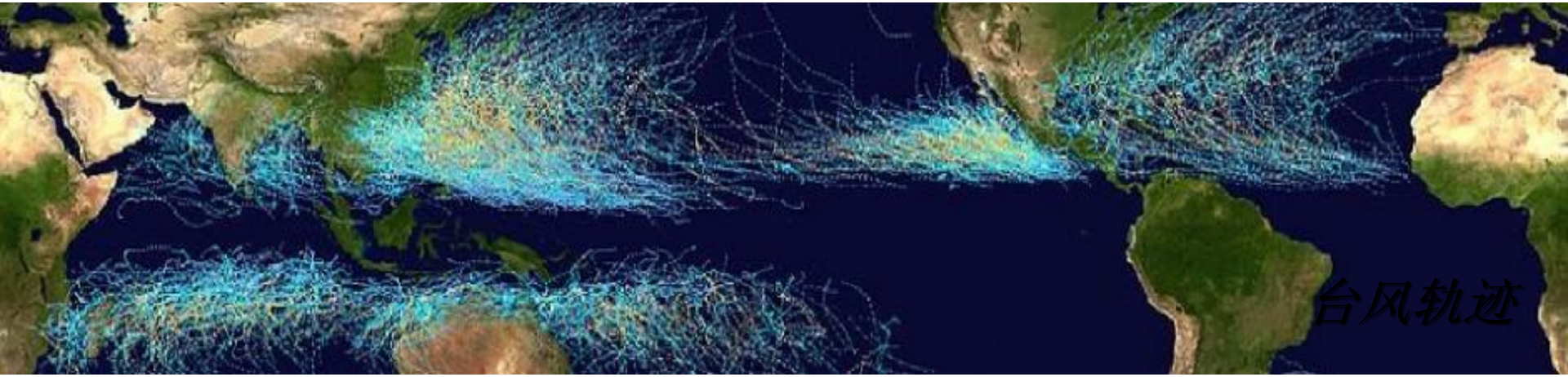
形成

HAB

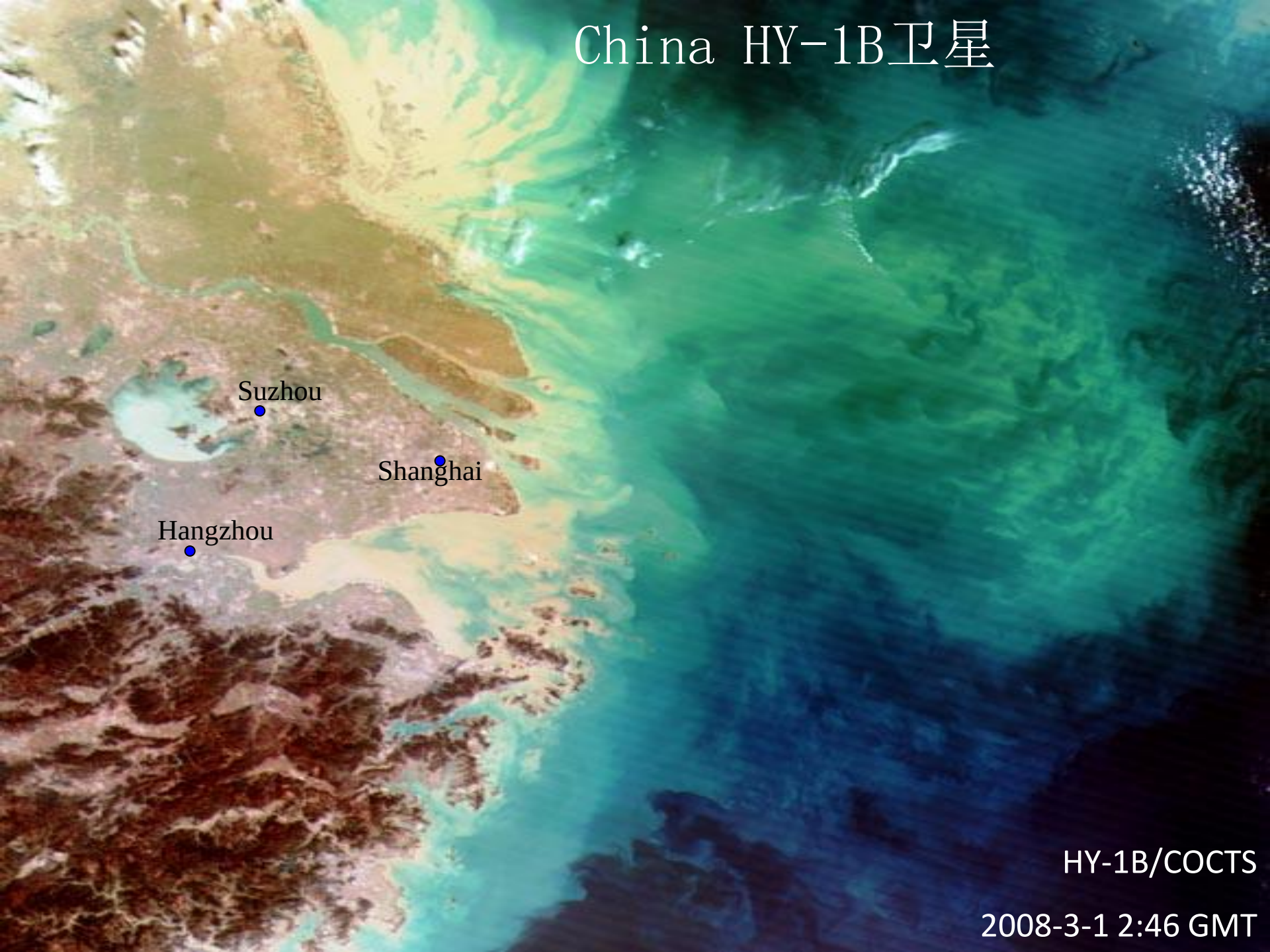
海洋灾害

Respirations

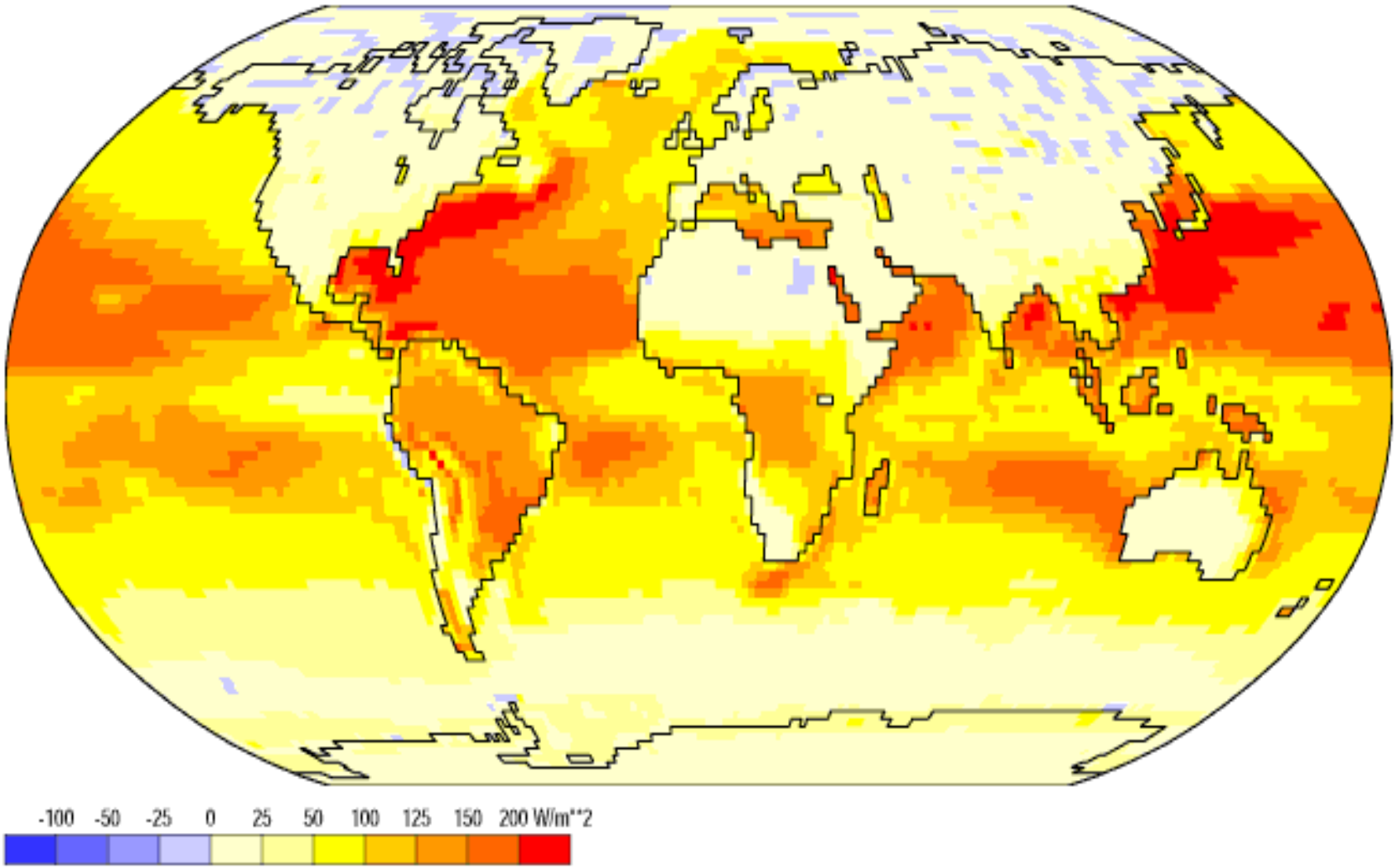




China HY-1B卫星

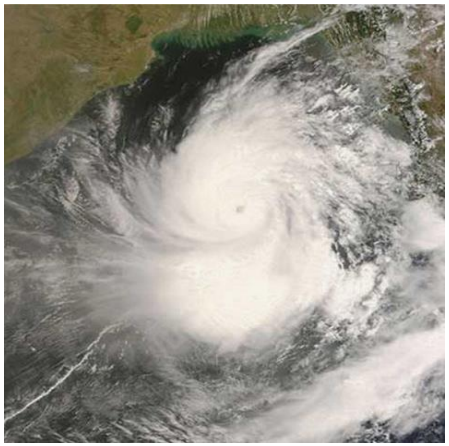


Respirations



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

Climate Changes /Natural Hazards



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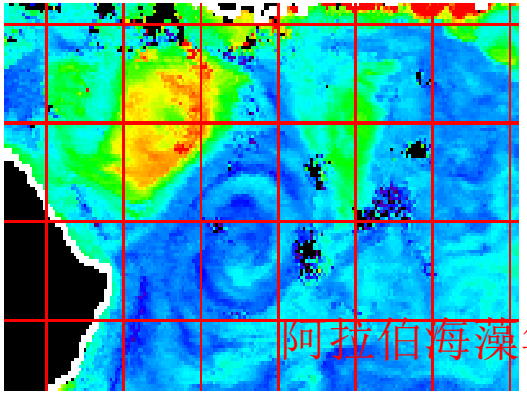


Phytoplankton Blooms

Nutrient /light-temperature

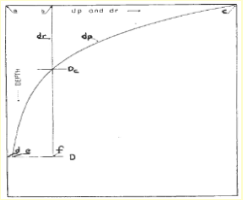
1. critical depth hypothesis

：

（Sverdrup 1953）.

混合层深度 < 临界深度时，

海洋藻华才可能发生



Gran and Braarud 1935　提出

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.

2. "Eutrophication"

（Edmondson， 1975）

human activities-

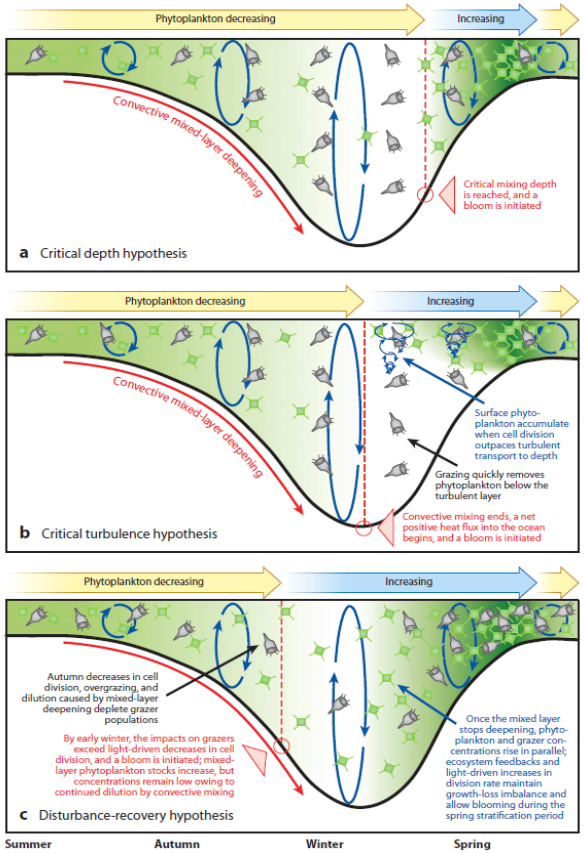
ABNORMAL LEUCOCYTE COMPOSITION
AND SODIUM TRANSPORT IN ESSENTIAL
HYPERTENSION
R. P. S. Edmondson　R. D. Thomas
P. J. Hilton　J. Patrick *
N. F. Jones
Renal Laboratory, St. Thomas' Hospital, London SE1

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

半个多世纪以来， 这些理论得到细化、深化、和发展

critical depth hypothesis



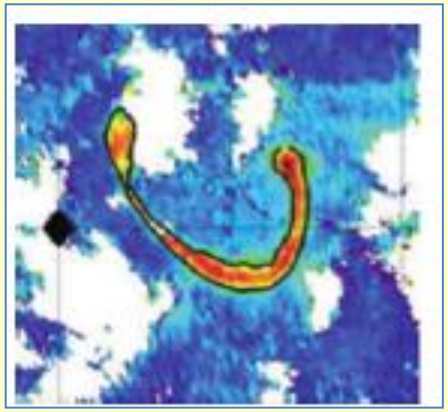
临界深度假说
critical depth hypothesis

临界湍流假说
the critical turbulence H

干扰-恢复假说
disturbance-recovery H

Eutrophication

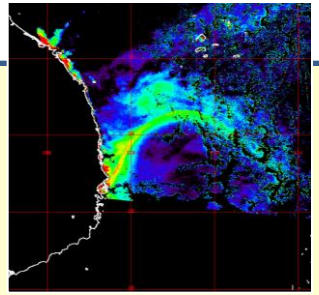
N
P
N： P
Fe

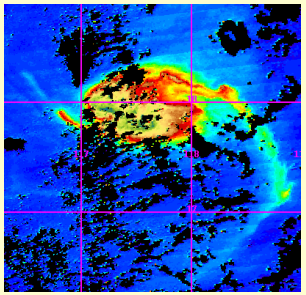


Resurrecting the Ecological Underpinnings of Ocean Plankton Blooms

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





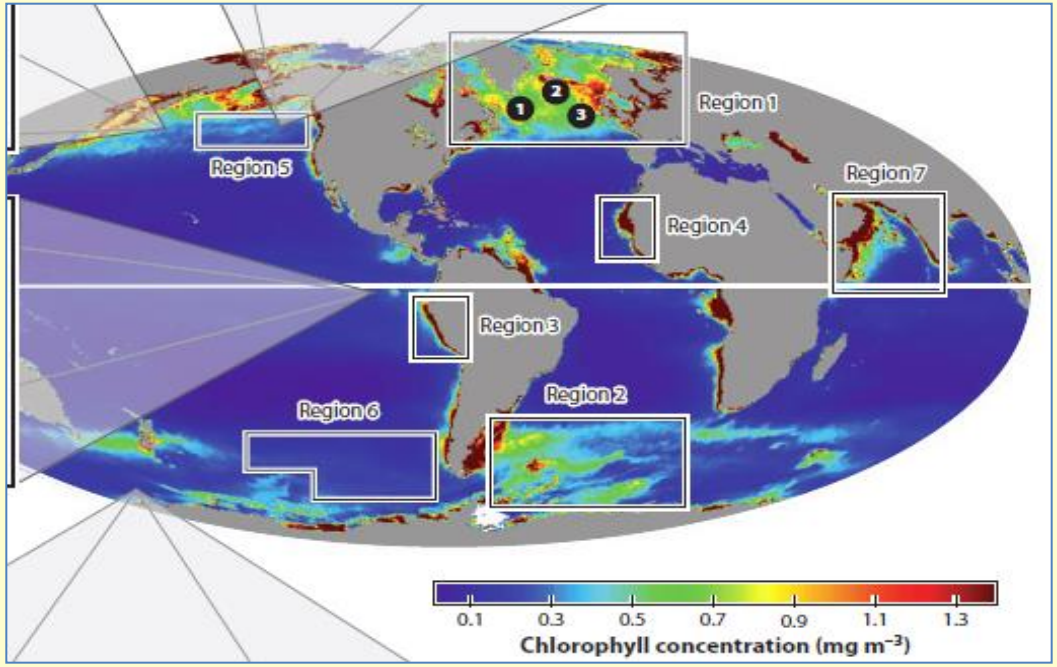
无法解释

- 非 局地形成
- 形成时间与位置不固定
- 持续时间较短

- 卫星遥感发现的海洋大藻华：

- 混合层深度 〉 临界深度
- 非富营养化海域 (南海测不出N)
- 时间与海域复杂多变

SeaWiFS卫星
夏季叶绿素含量



Scientific question

Driver?

Ocean dynamic ?

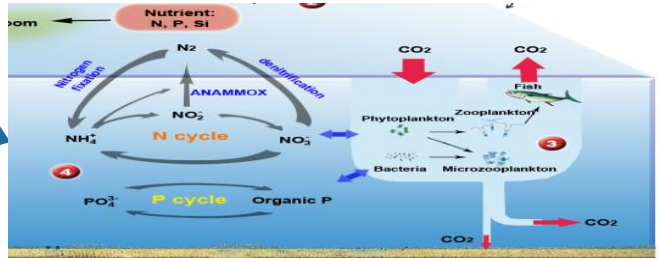
Climate change→Marine Ecosystem→Phytoplankton?

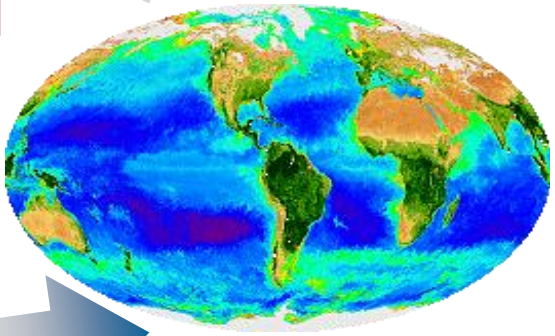
Climate Changes

Co2

wind

Marine system





Phytoplankton

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,[10,19] 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,[5,7] 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,[1*†] Laurence Garczarek,[2,3†] Sabrina Speich,[4,5,6¶] 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,[5,11] Jean-Pierre Gattuso,[9,10] Nicolas Grima,[5] Lionel Guidi,[9,10] Christopher N. Hill,[8] Oliver Jahn,[8] Jean-Louis Jamet,[12] Hervé Le Goff,[12] 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,[12] 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,[4#] Stéphane Pesant,[21,22] Matthew B. Sullivan,[6**] Shinichi Sunagawa,[17] Patrick Wincker,[14,15,16] Eric Karsenti,[4,12*] Chris Bowler,[2*] 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,[10,11,6,1,2] Samuel Chaffron,[12,13,14] Micah Dunthorn,[5] 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,[6] Raphael Morard,[22,1,2] Matthieu Mulot,[5] Eleonora Scalco,[23] Raffaele Siano,[24] Flora Vincent,[13,6] Adriana Zingone,[23] Céline Dimier,[1,2,6] 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,[6] Gabriel Gorsky,[17,18] Nigel Grimsley,[28,29] Pascal Hingamp,[30] Daniele Iudicone,[23] Fabrice Not,[1,2] Hiroyuki Ogata,[31] Stephane Pesant,[32,33] 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[6,8*]

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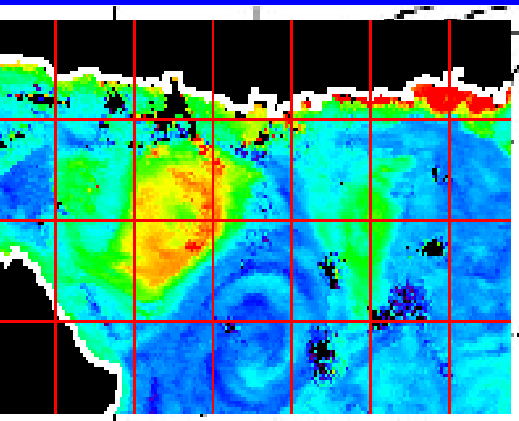
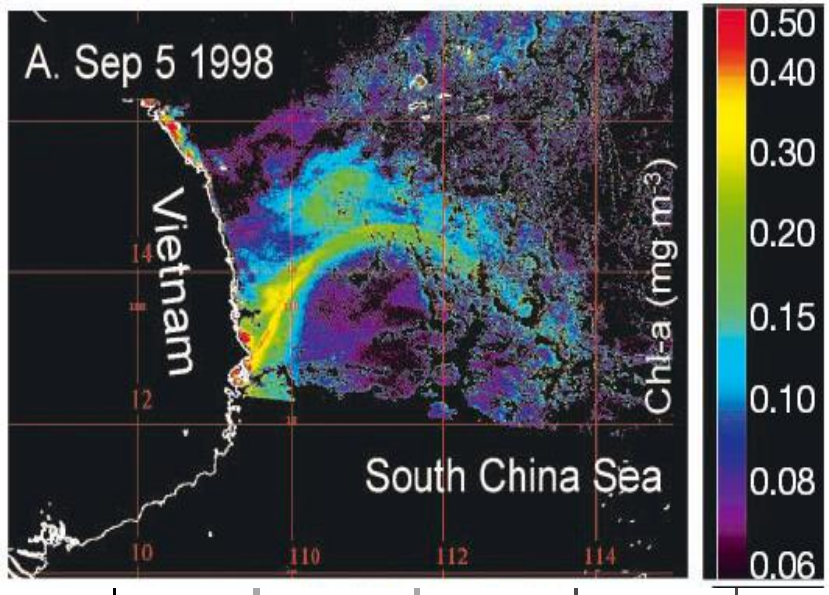
Resurrecting the Ecological Underpinnings of Ocean Plankton Blooms

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

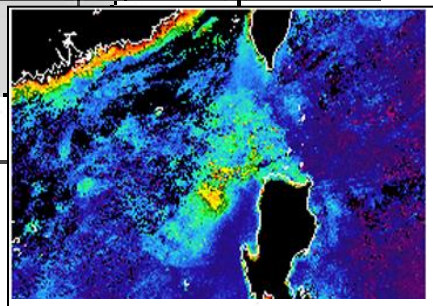
Cold eddy – upwelling-phytoplankton bloom /

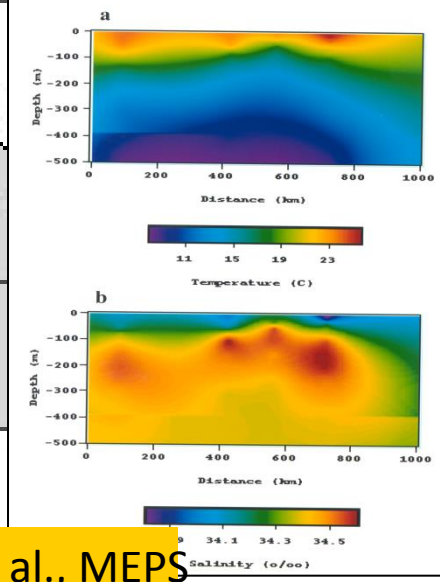
DanLing TANG





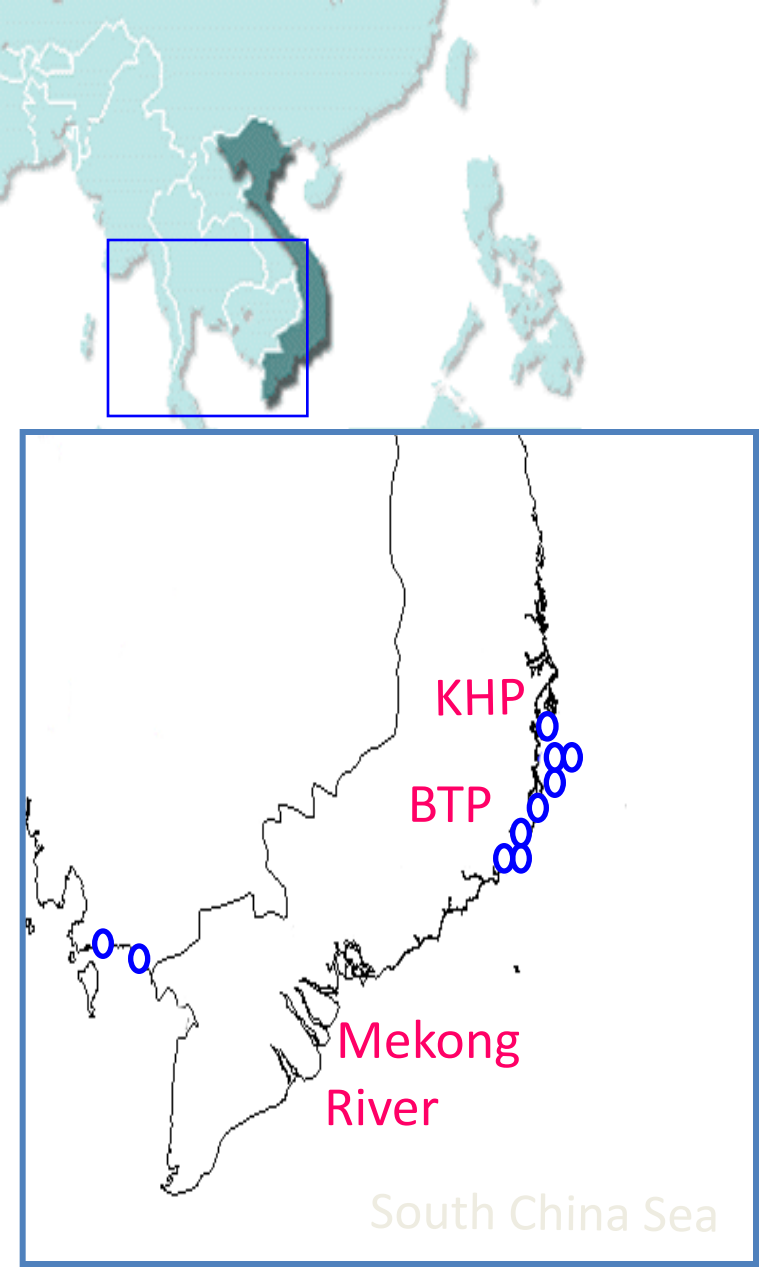
Upwelling





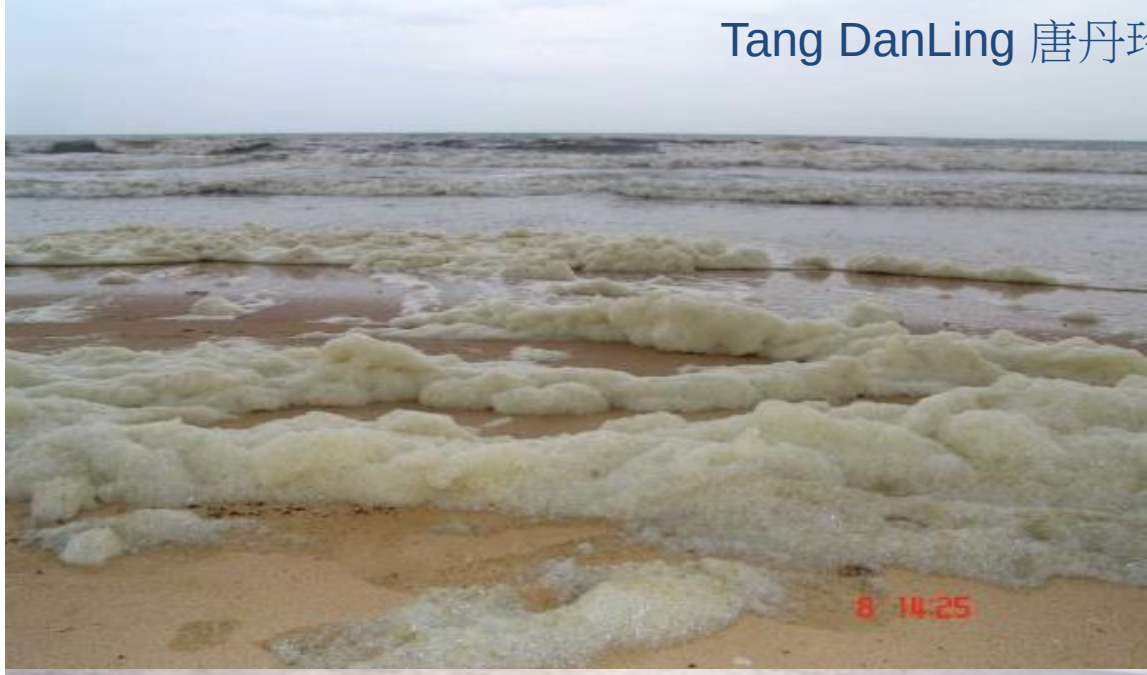
Tang et al., JGR, MEPS, JGR, JGR

Tang et al., MEPS

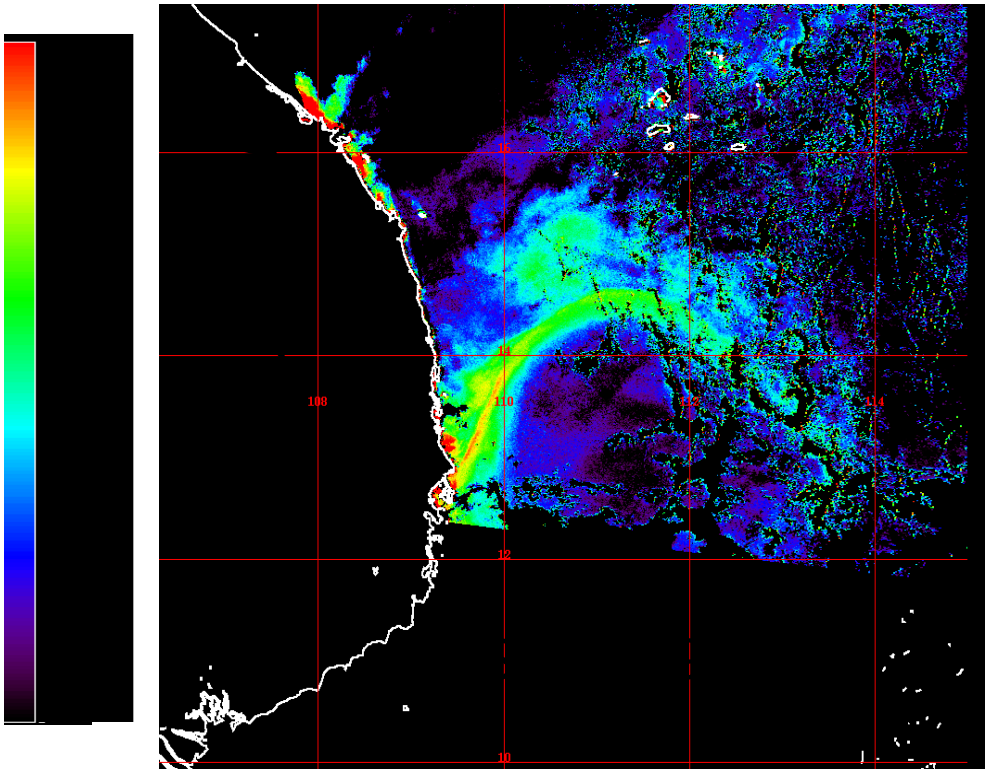


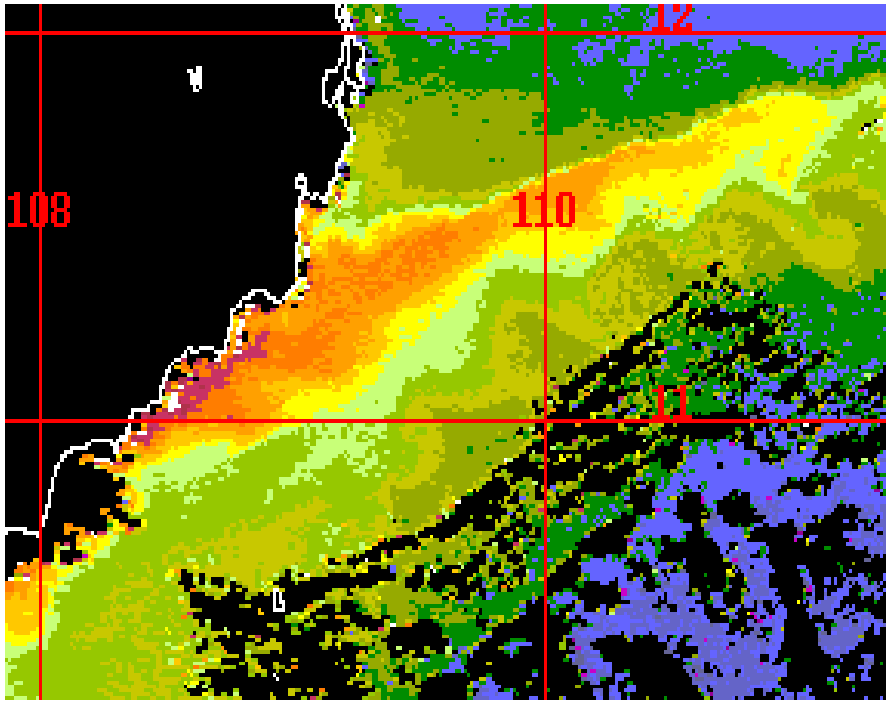
Tang DL et al., 2004, GJR

Tang DanLing 唐丹玲



http://lingzis.51.net/





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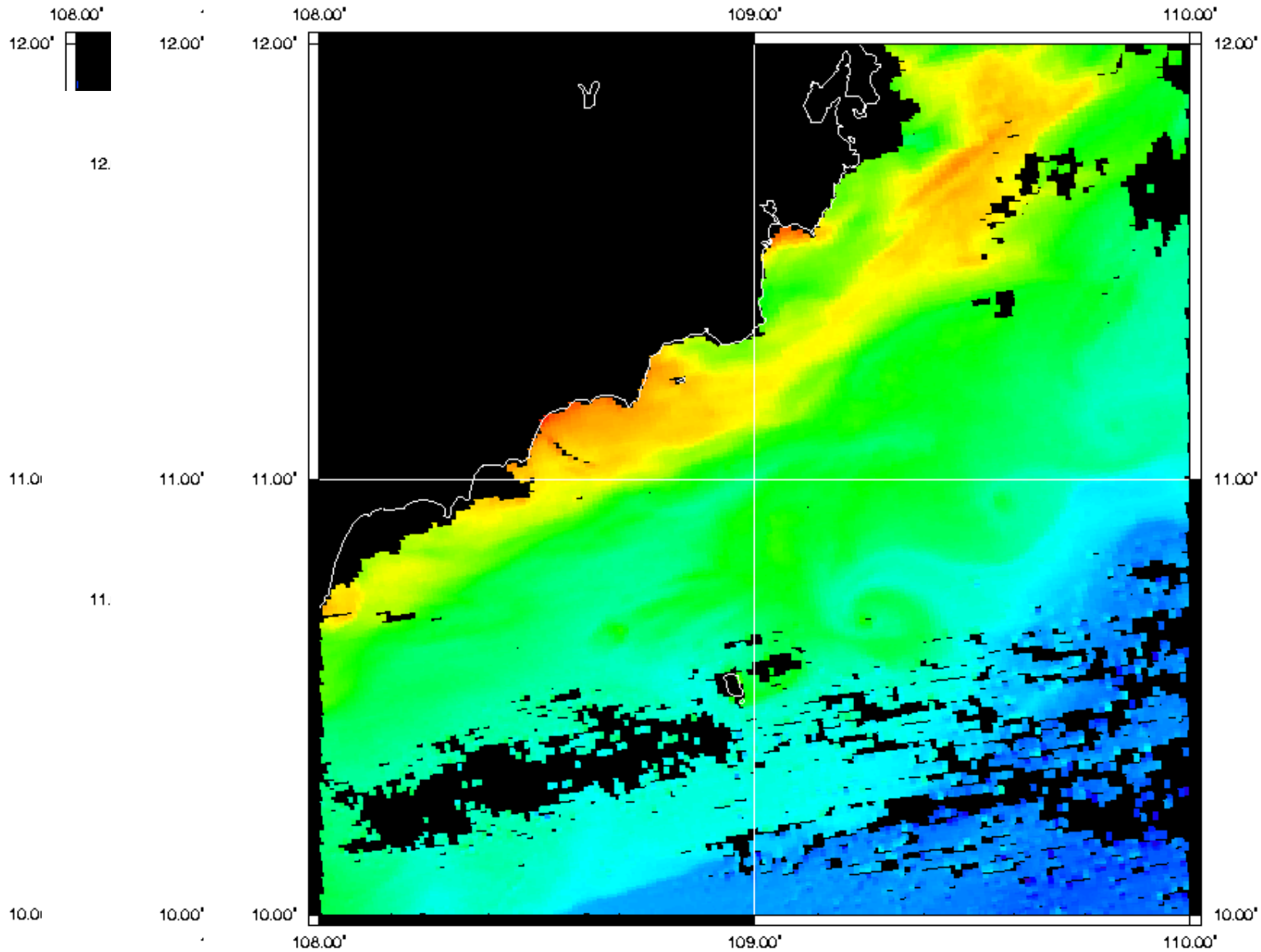
Offshore water?

(Tang et al.2004, JGR)

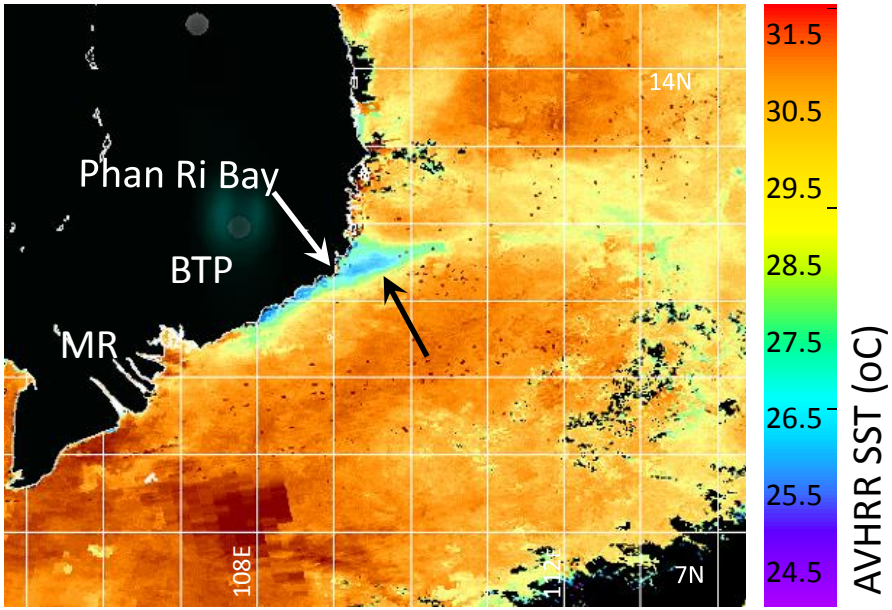


A2006192062500.L2_LAC.Vietnam.chlor_a

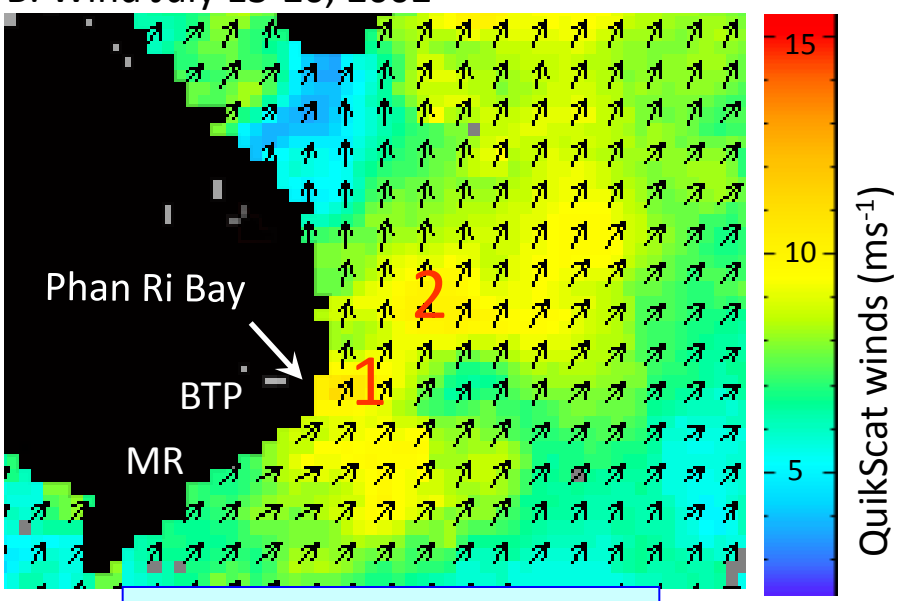
Chlorophyll Concentration (mg/m^3)

0.01 0.1 1 10 60

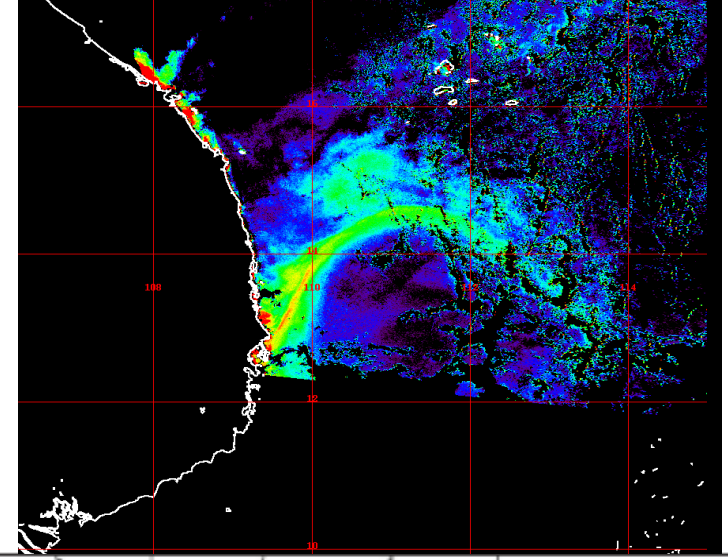
A. SST July 23, 2002

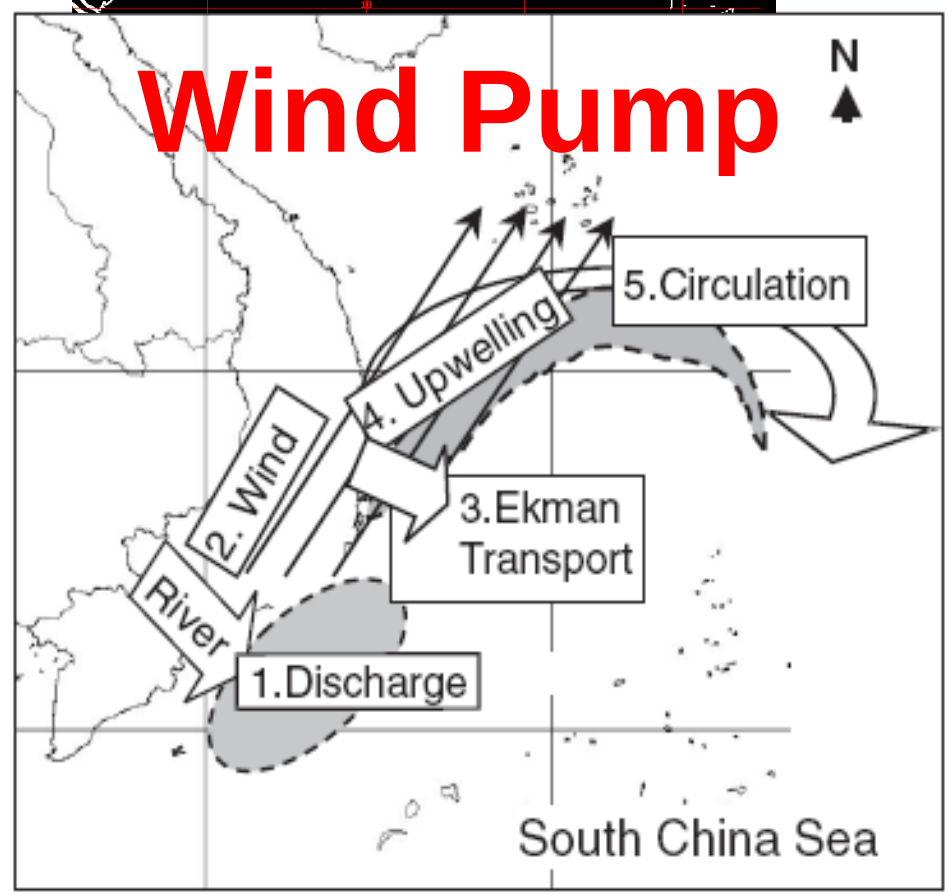


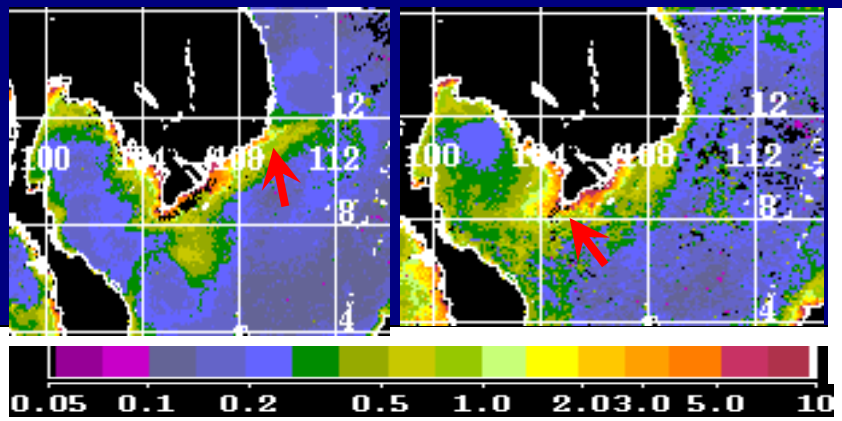
B. Wind July 13-20, 2002

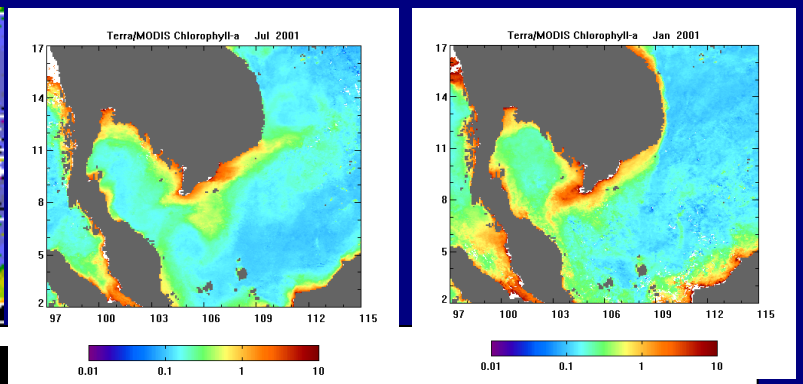


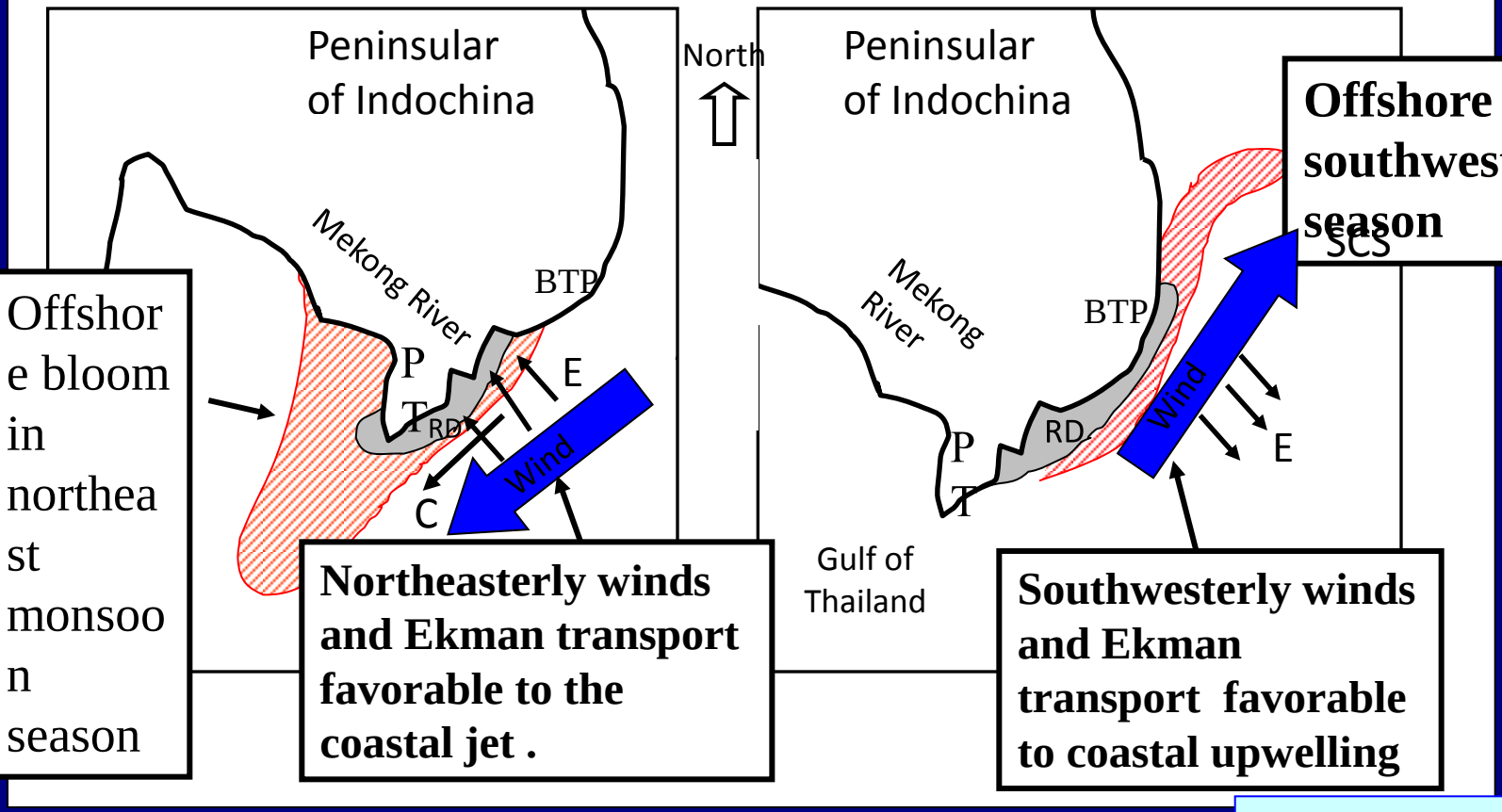
Tang et al., 2004. JGR



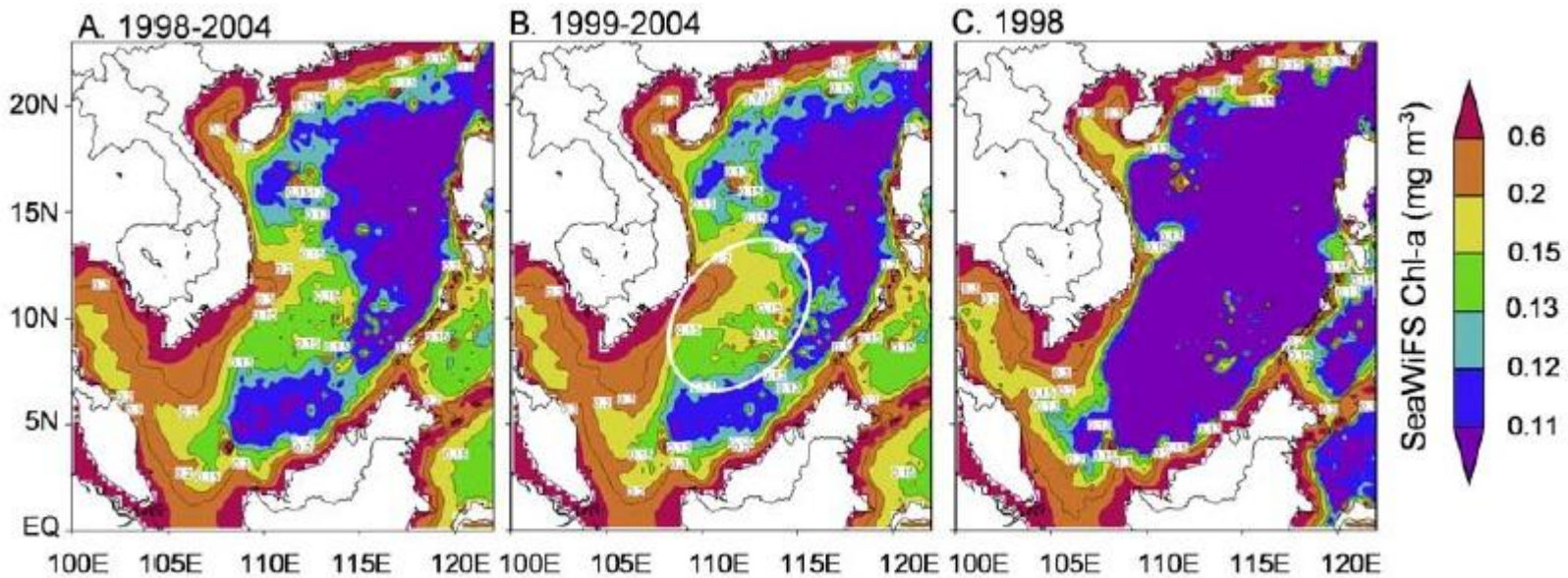


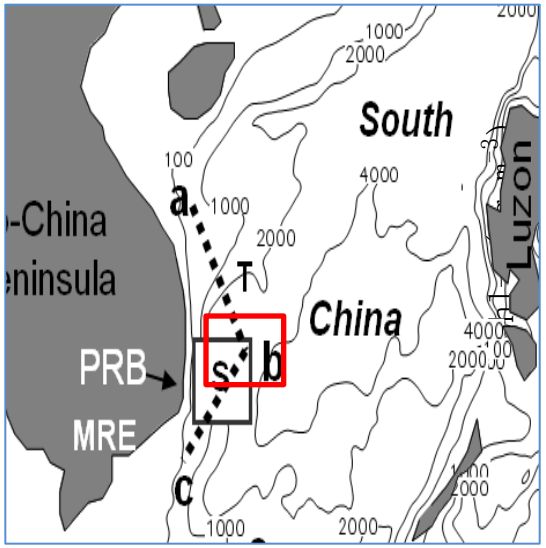


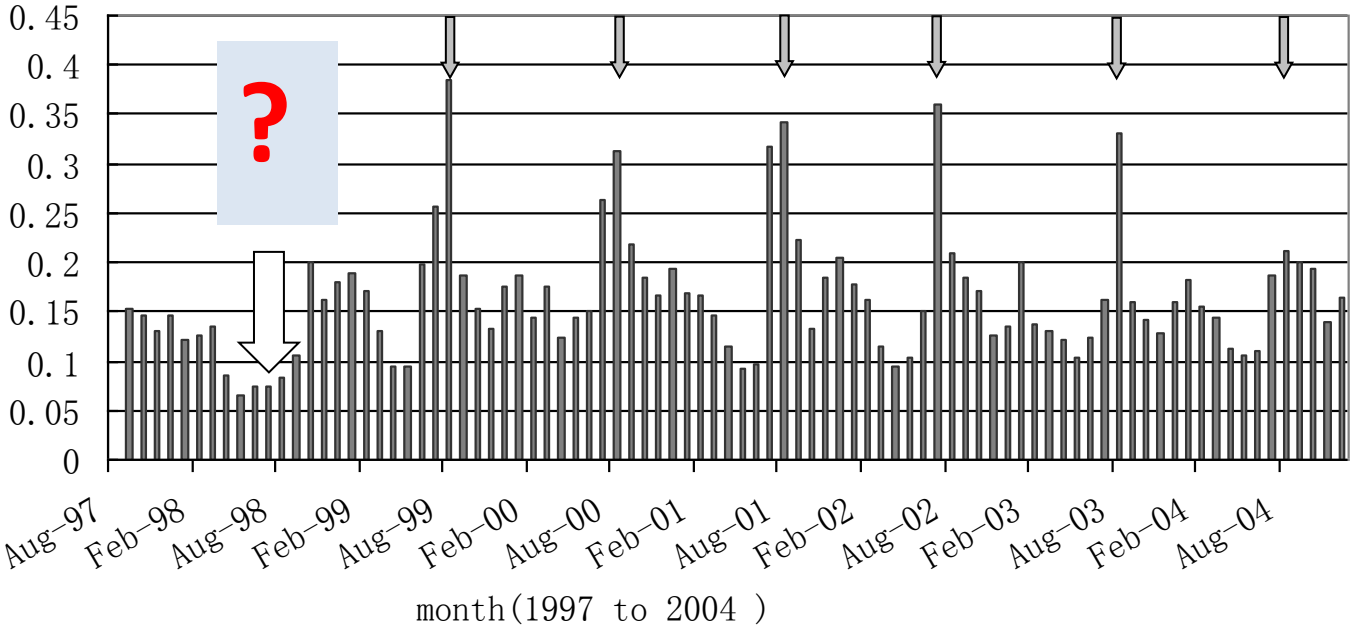


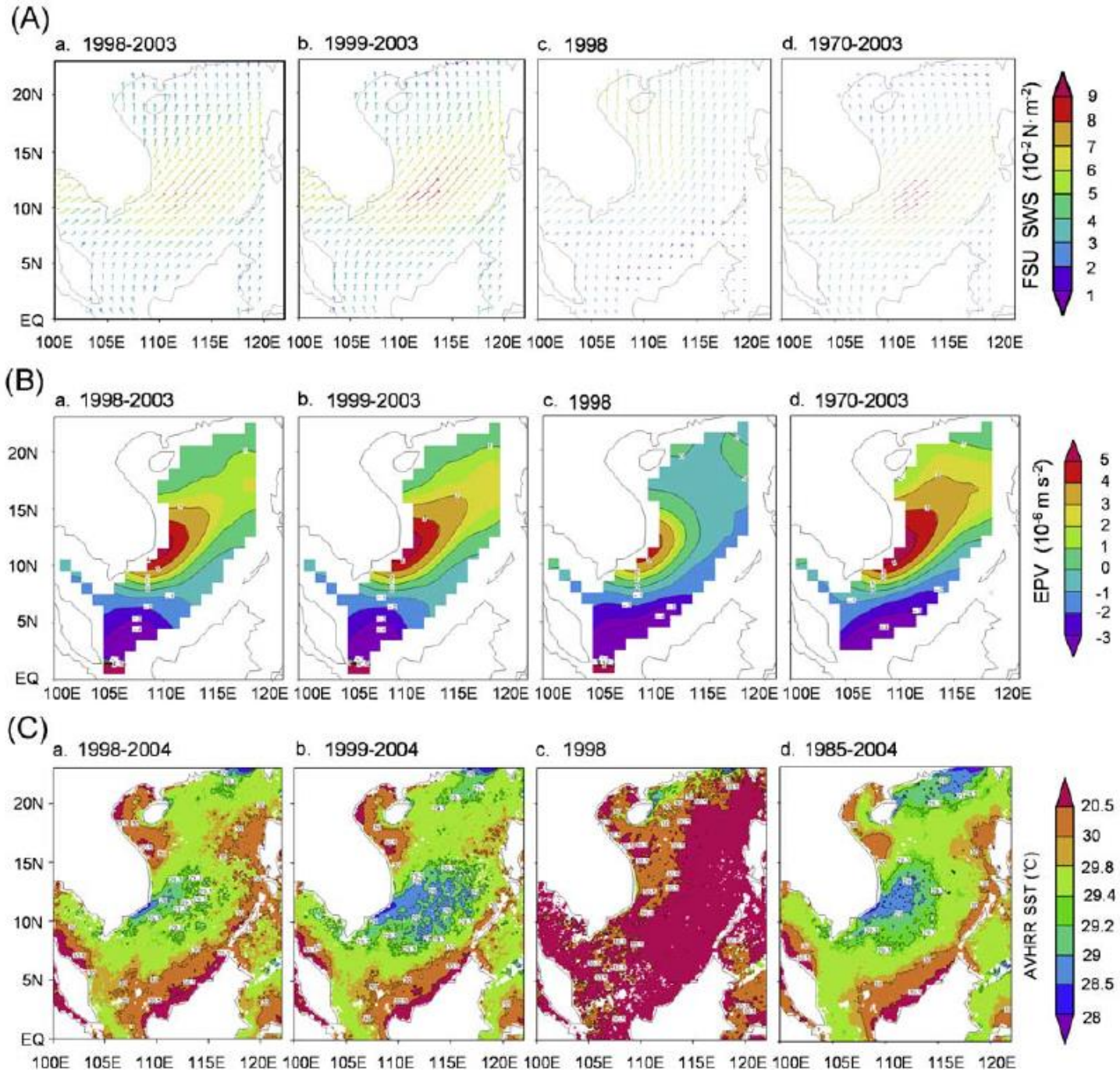


Tang et al., 2006, JGR

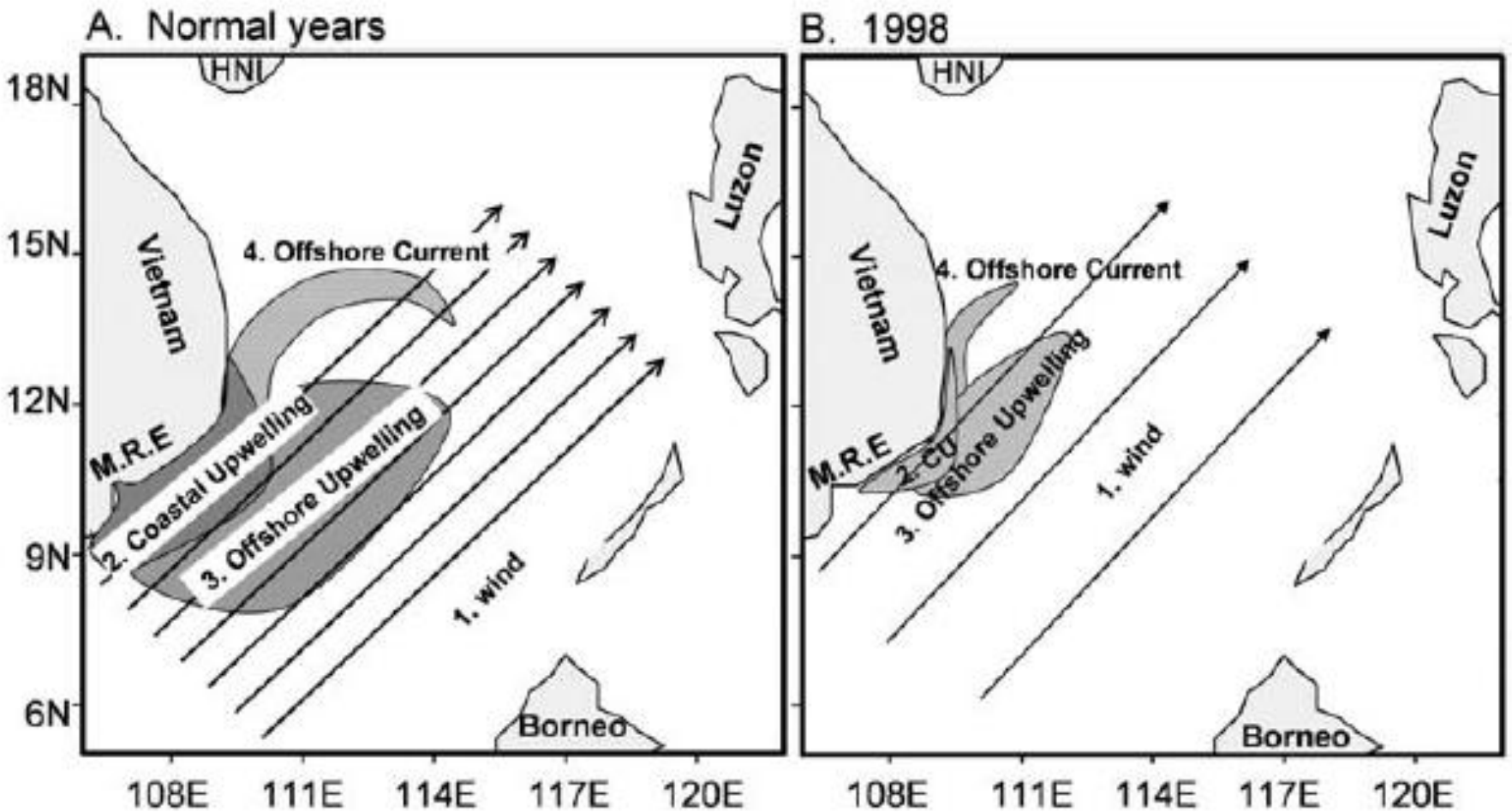

A. 1998-2004
B. 1999-2004
C. 1998
20N
15N
10N
5N
EQ
100E
105E
110E
115E
120E
SeaWiFS Chl-a (mg m-3)
0.6
0.2
0.15
0.13
0.12
0.11


South
China
Luzon
PRB
MRE
a
b
c
s
T
1000
2000
4000
100


?
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
20N
15N
10N
5N
EQ
100E 105E 110E 115E 120E
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

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!

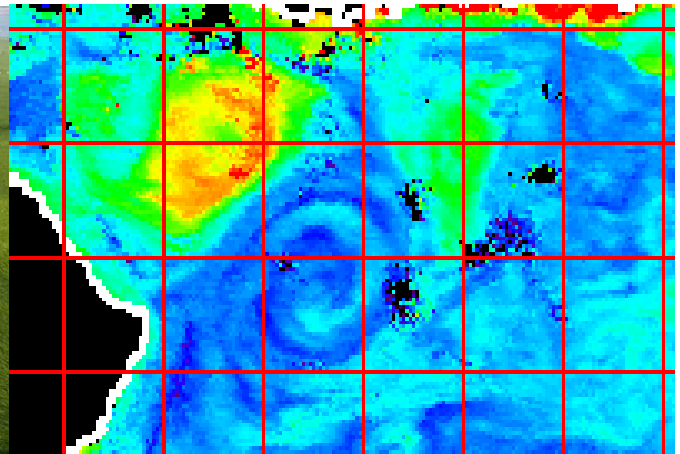
How about Typhoon?

Climate Change → SST –> Typhoon

?

Marine ecosystem

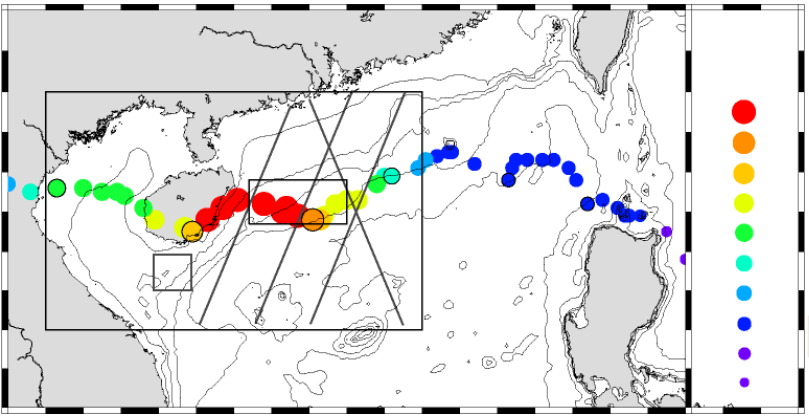
phytoplankton



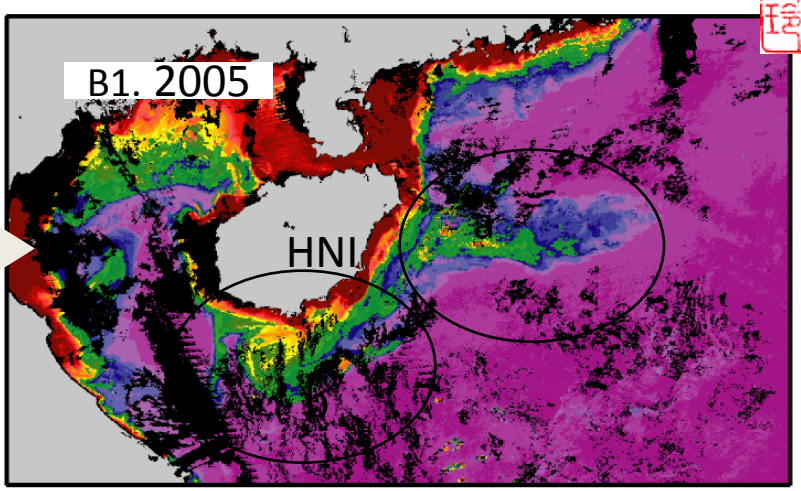
中科院南海海洋研究所 唐丹玲

3 Typhoon impact on Marine Ecosystem

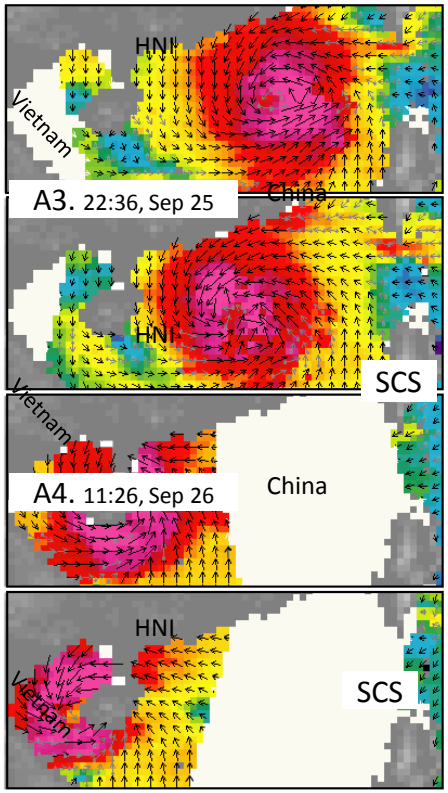
DanLing TANG



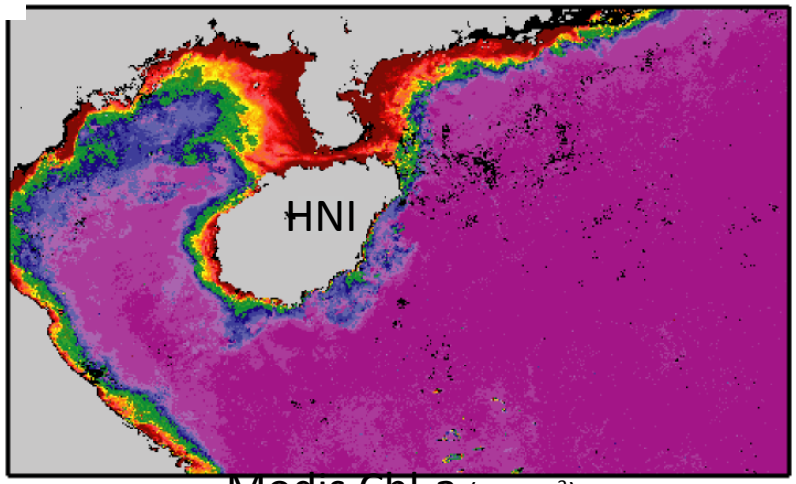
B. Post-typhoon Chl-a



Damrey,
Sep 2005
SCS



B2. 2002-2004

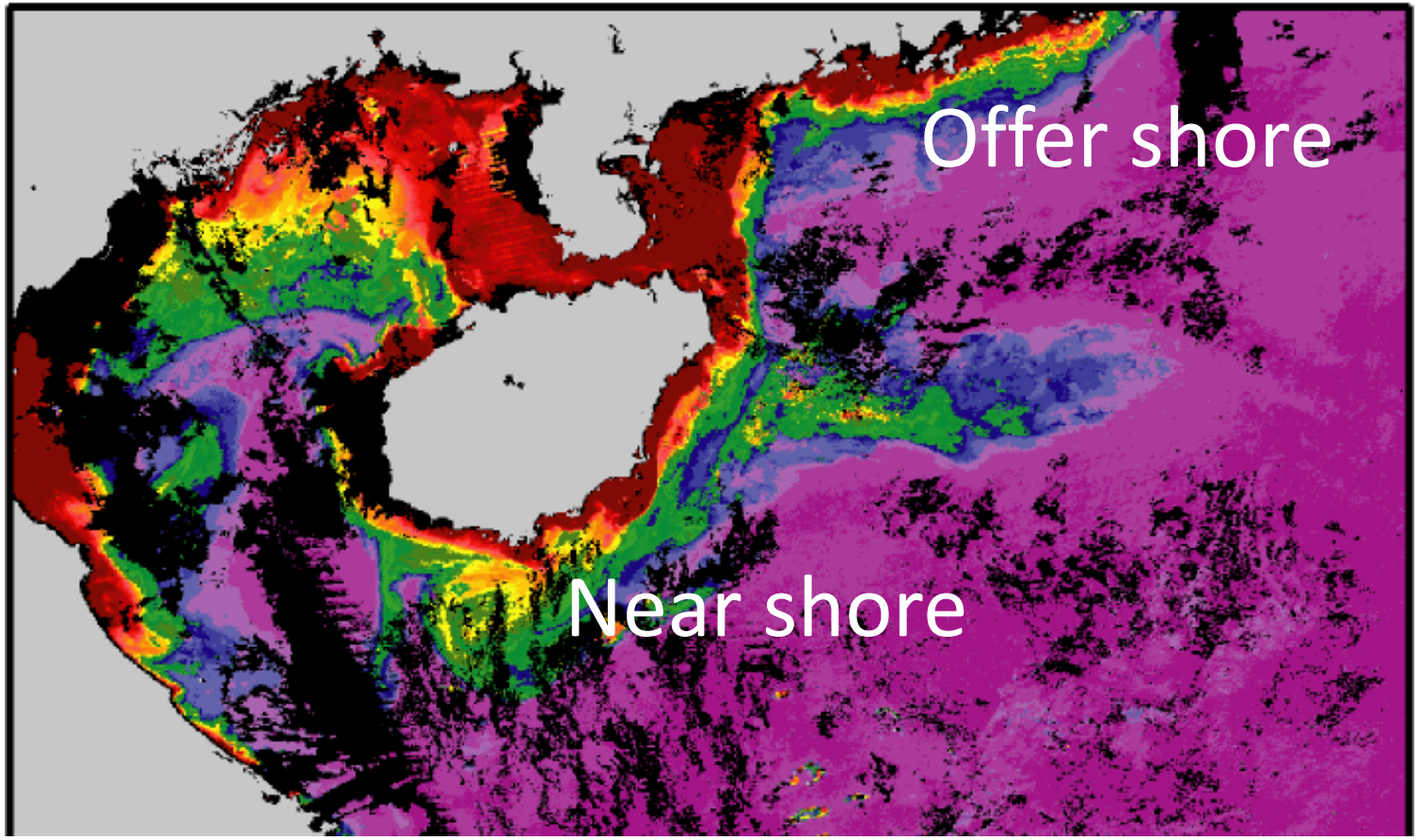


Modis Chl-a (mg m^{-3})

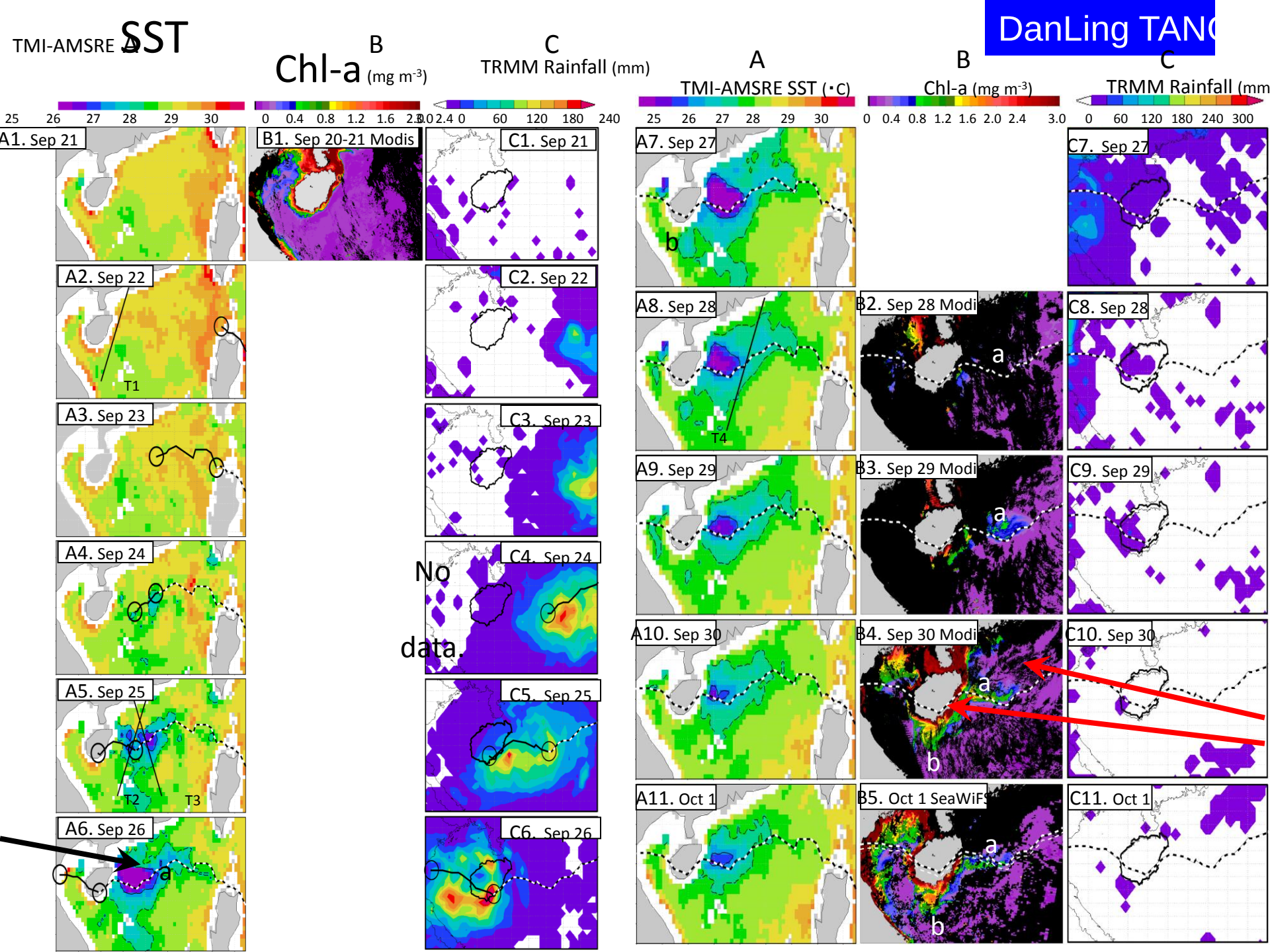
QuikScat
Wind
Vectors (m/s)

Zheng and Tang, MEPS 2007

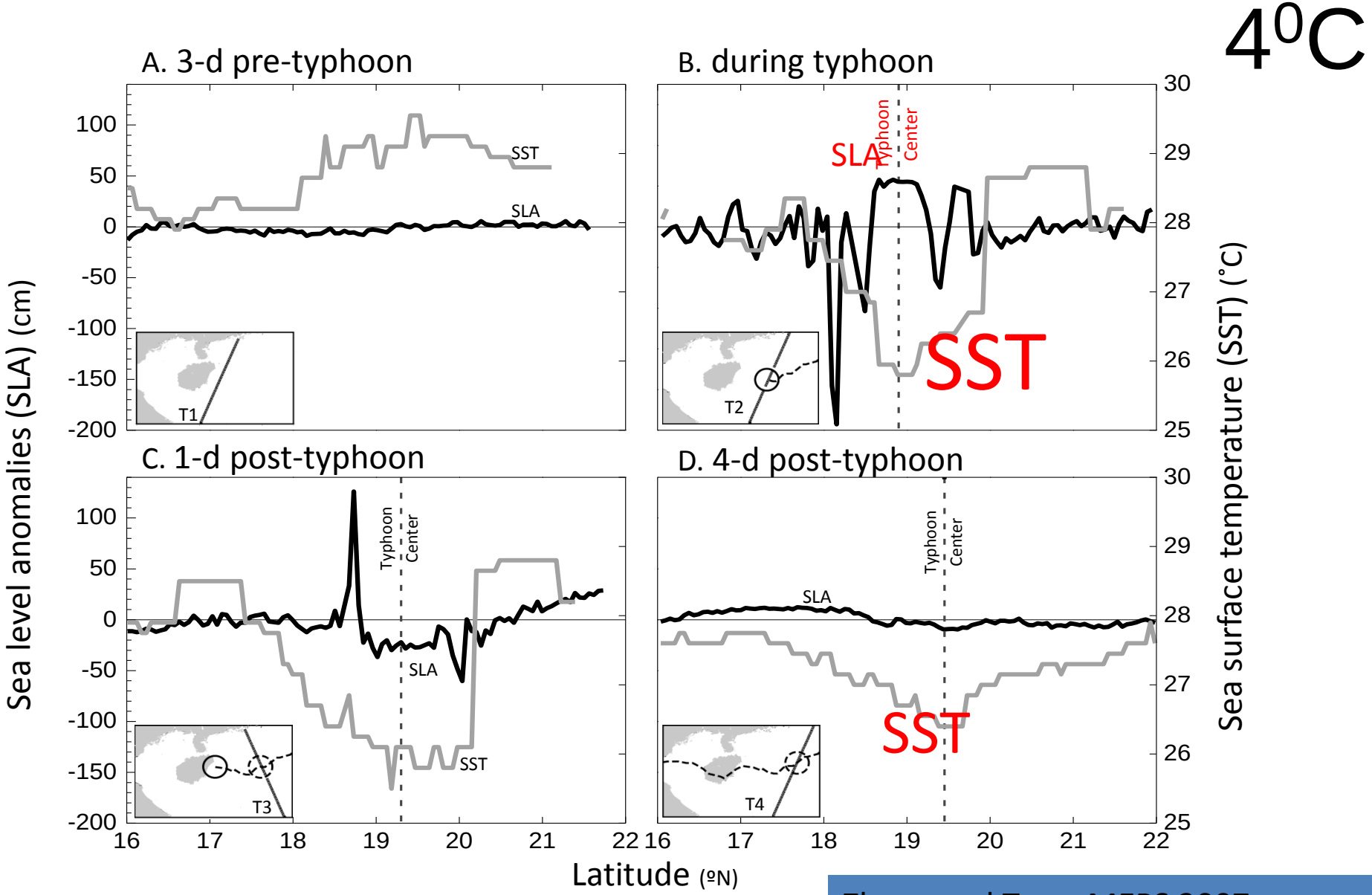
Offshore and nearshore chlorophyll increases induced by typhoon and typhoon rain.



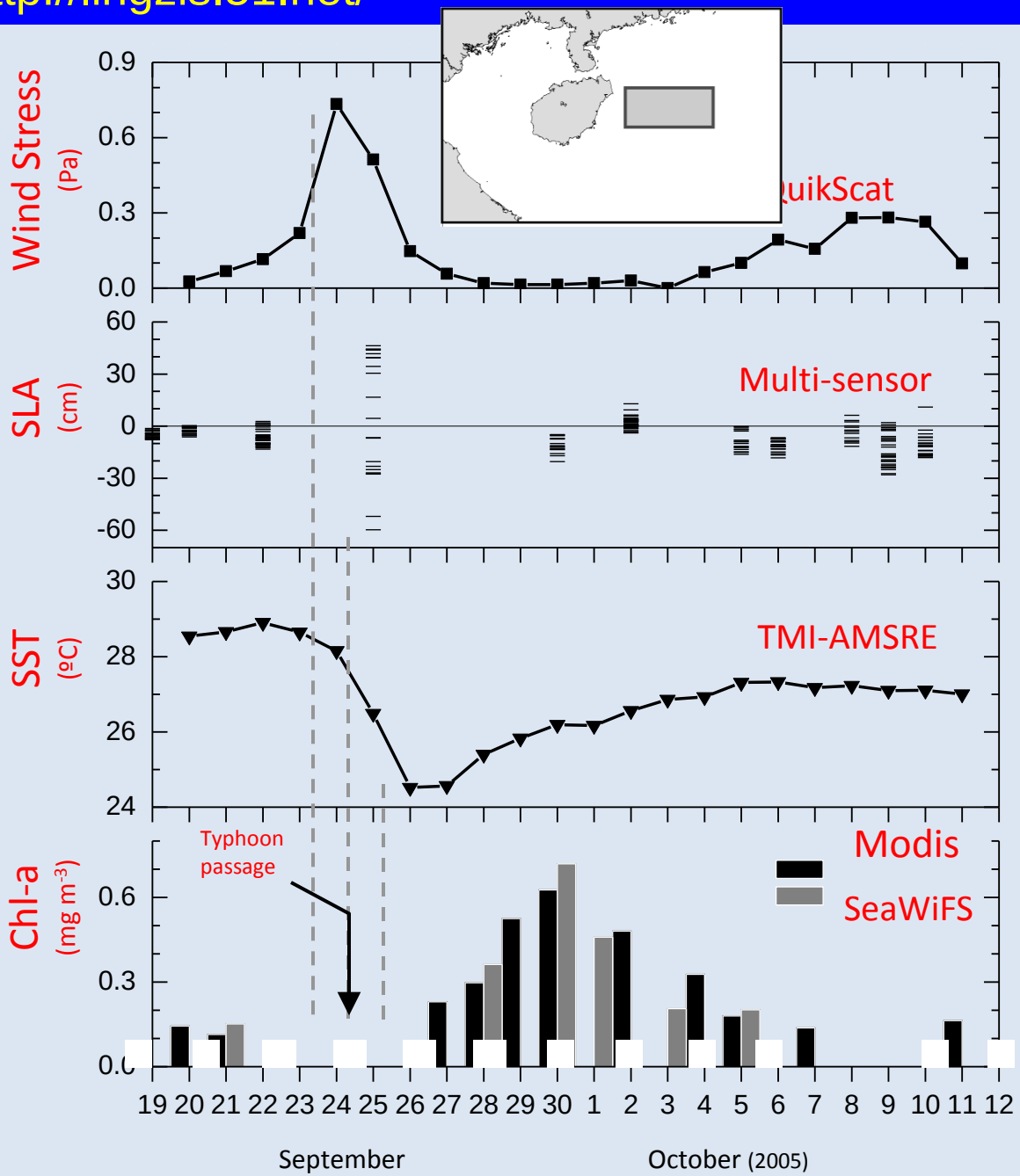
Guangming Zheng and Danling Tang, 2007,
Marine Ecology Progress Series, 333：61-74， 2007 (SCI)

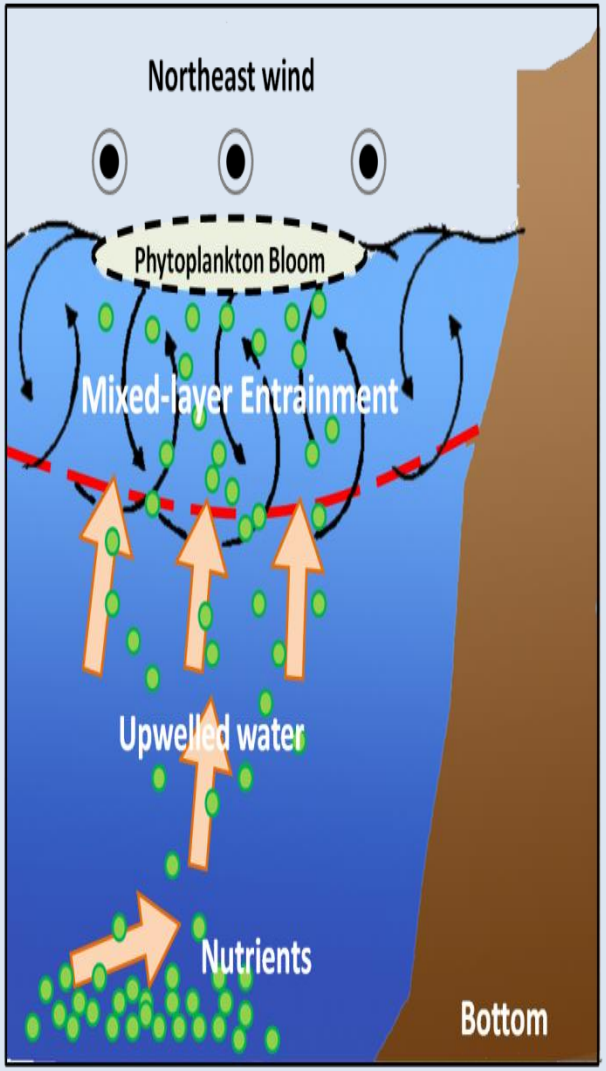

DanLing TANG
TMI-AMSRE SST
A
B
Chl-a (mg m-3)
C
TRMM Rainfall (mm)
25 26 27 28 29 30
0 0.4 0.8 1.2 1.6 2.0 2.4 3.0
0 60 120 180 240
A1. Sep 21
B1. Sep 20-21 Modis
C1. Sep 21
A2. Sep 22
T1
C2. Sep 22
A3. Sep 23
C3. Sep 23
A4. Sep 24
C4. Sep 24
No data.
A5. Sep 25
T2
T3
C5. Sep 25
A6. Sep 26
a
C6. Sep 26
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

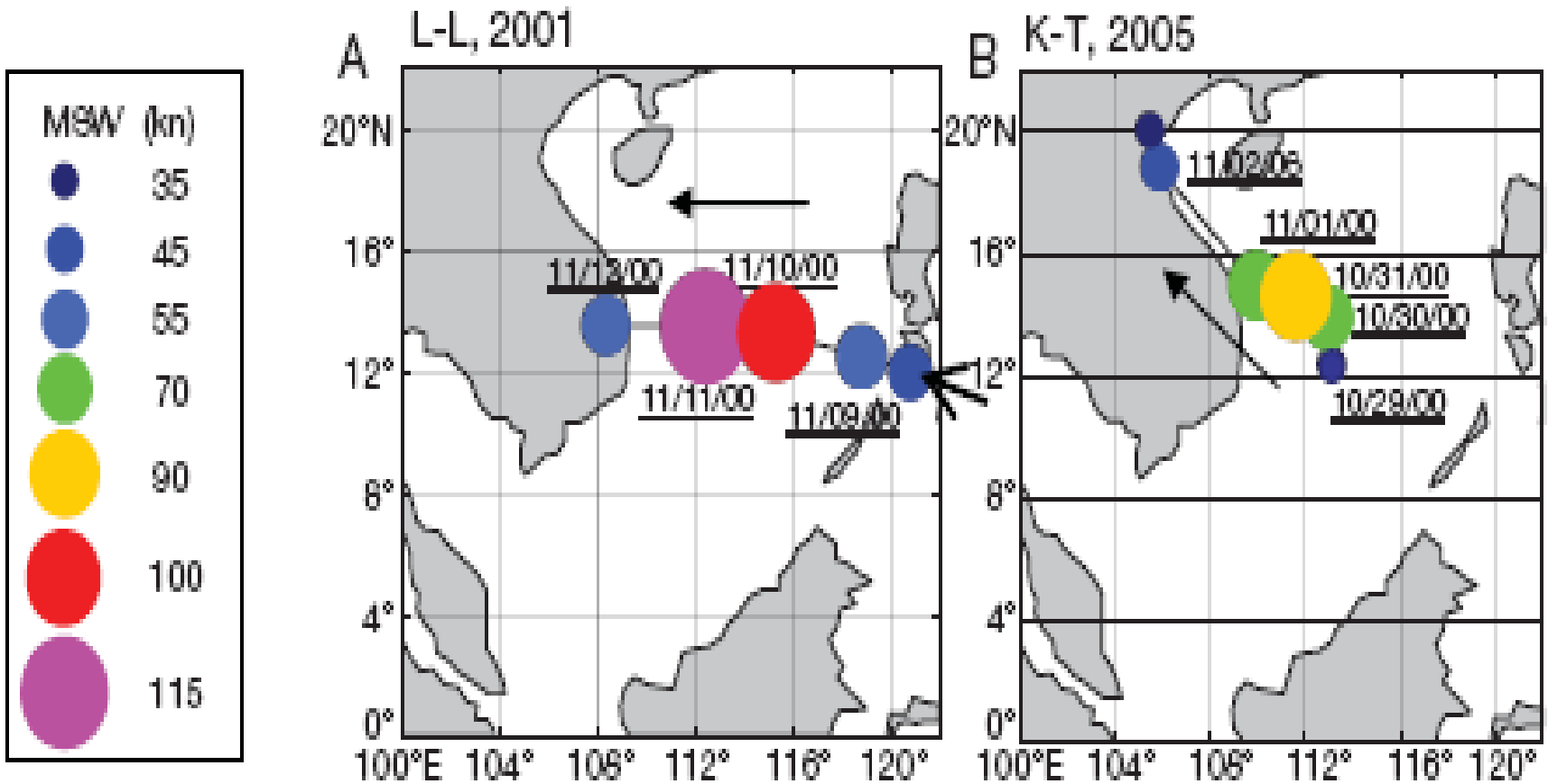




Wind Pump

Zheng and Tang, MEPS 200

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



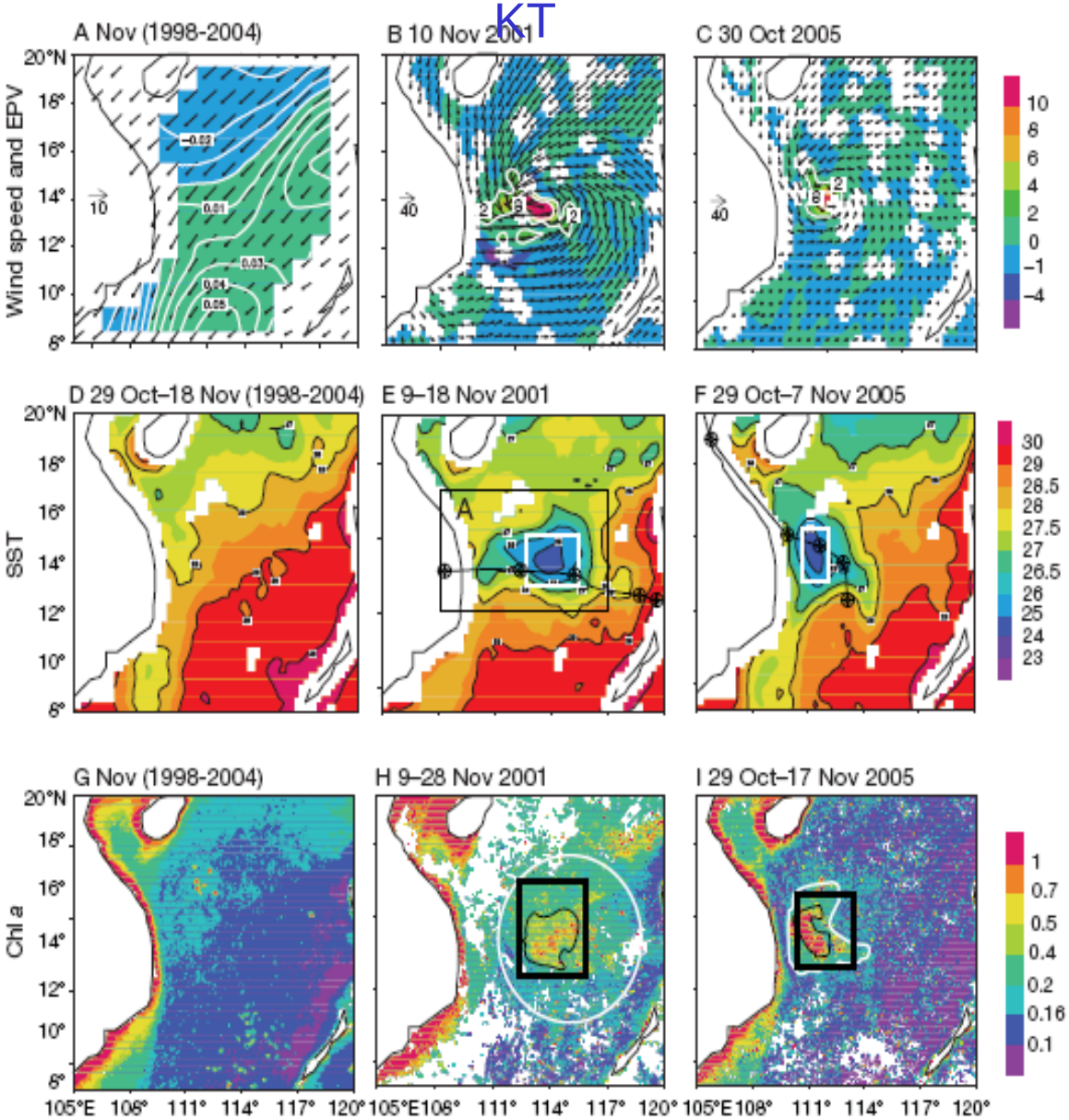
.) Track and intensity of typhoons L-L (2001) and K-T (2005) in the SCS. MSW: maximum sustaine
(in knots, 1 kn = 0.514 m s^{-1})

Zhao H, DanLingTang, Wang Y. 2008 MEPS

Strong, fast-moving (4.4m s-1)

Weak, slow moving (2.87 m s-1)

KT



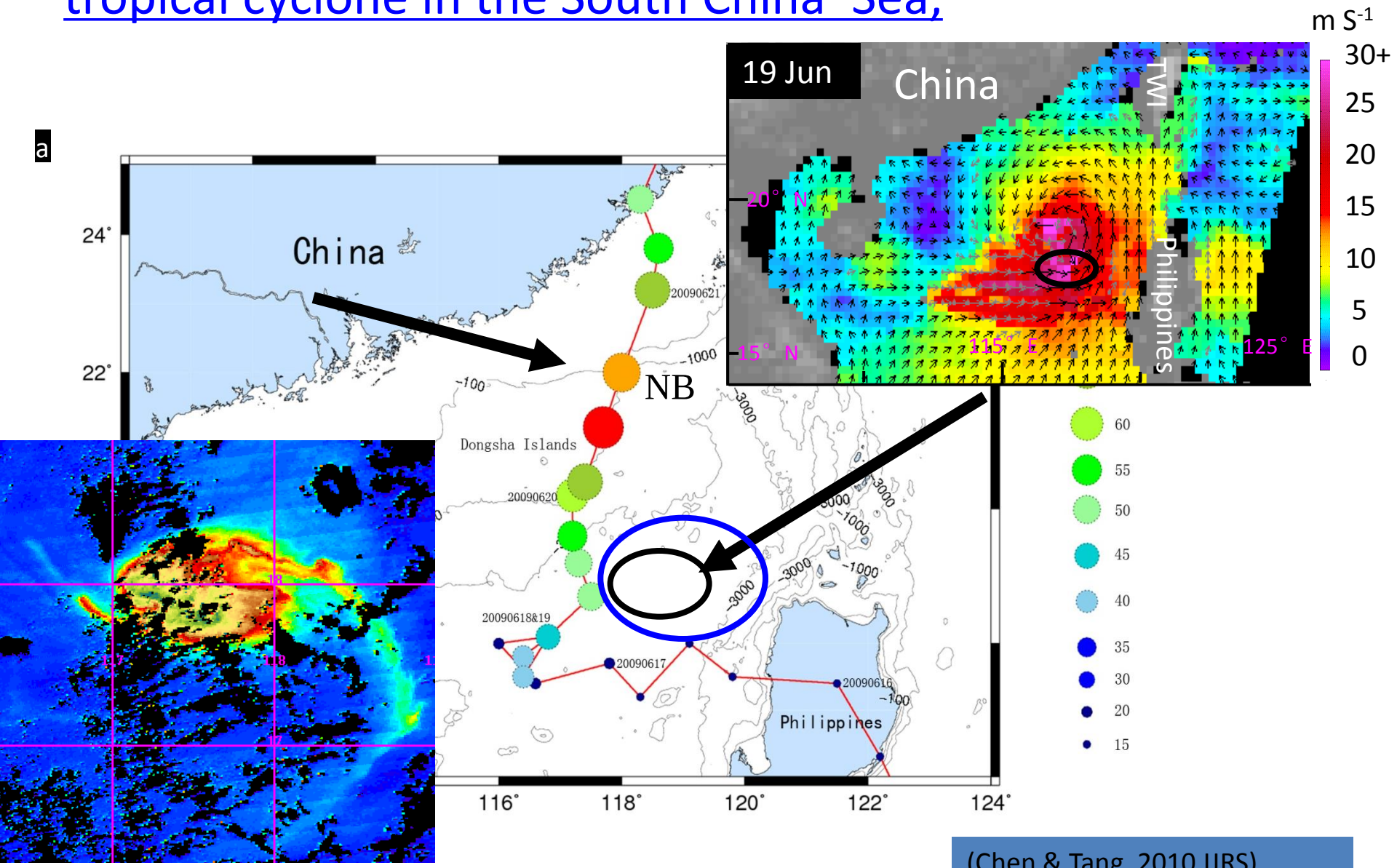
Wind

SST

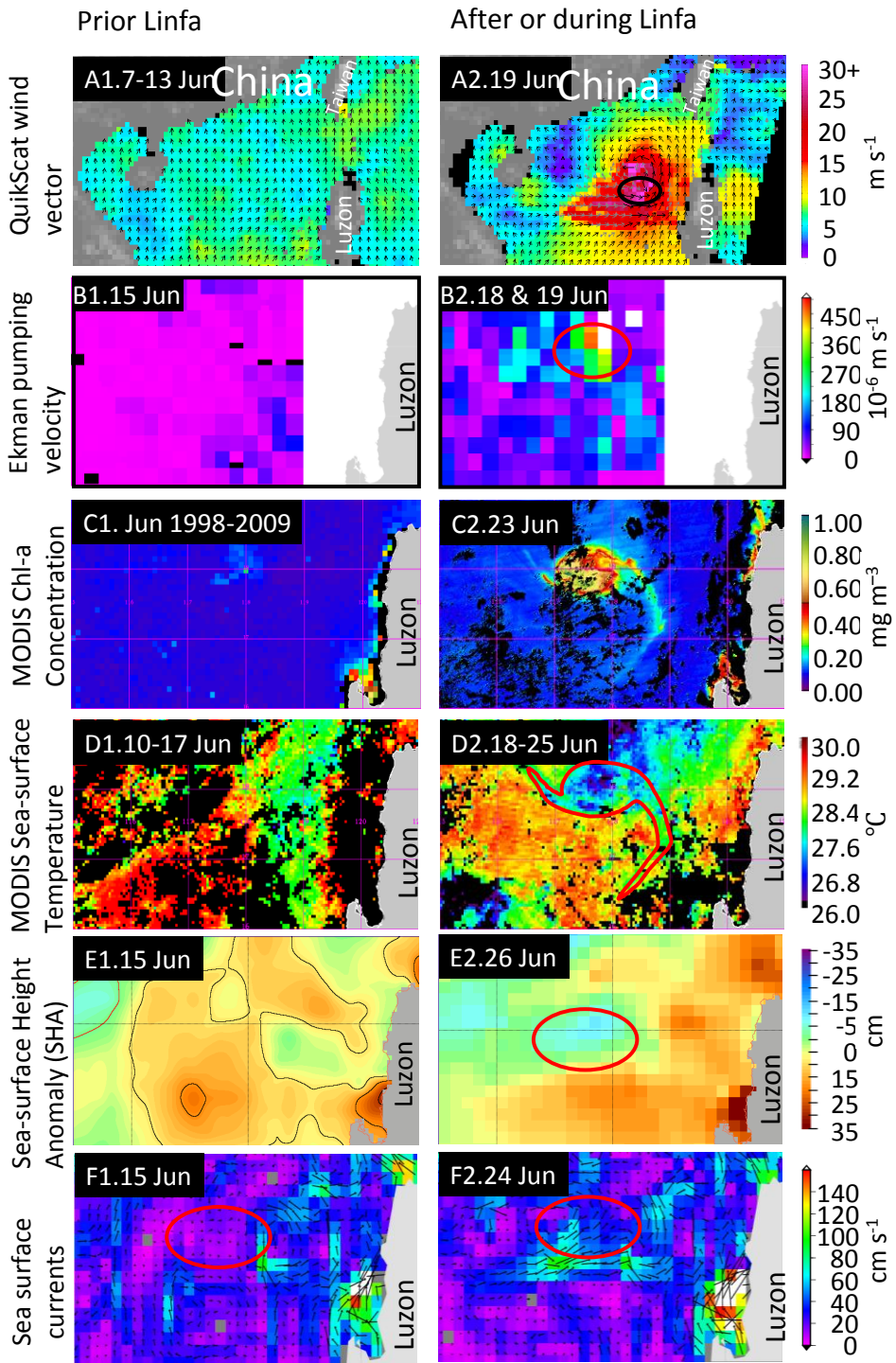
Chl a

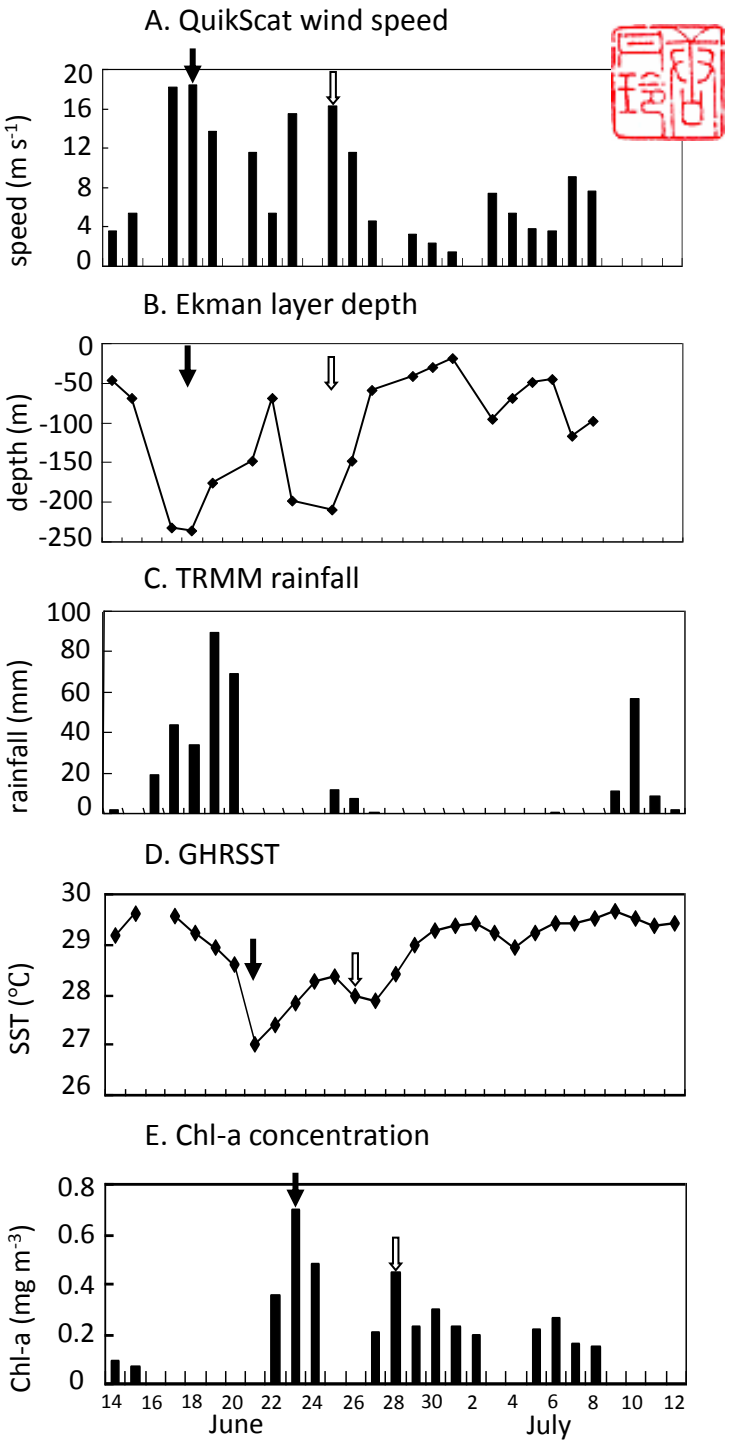
MEPS 2008

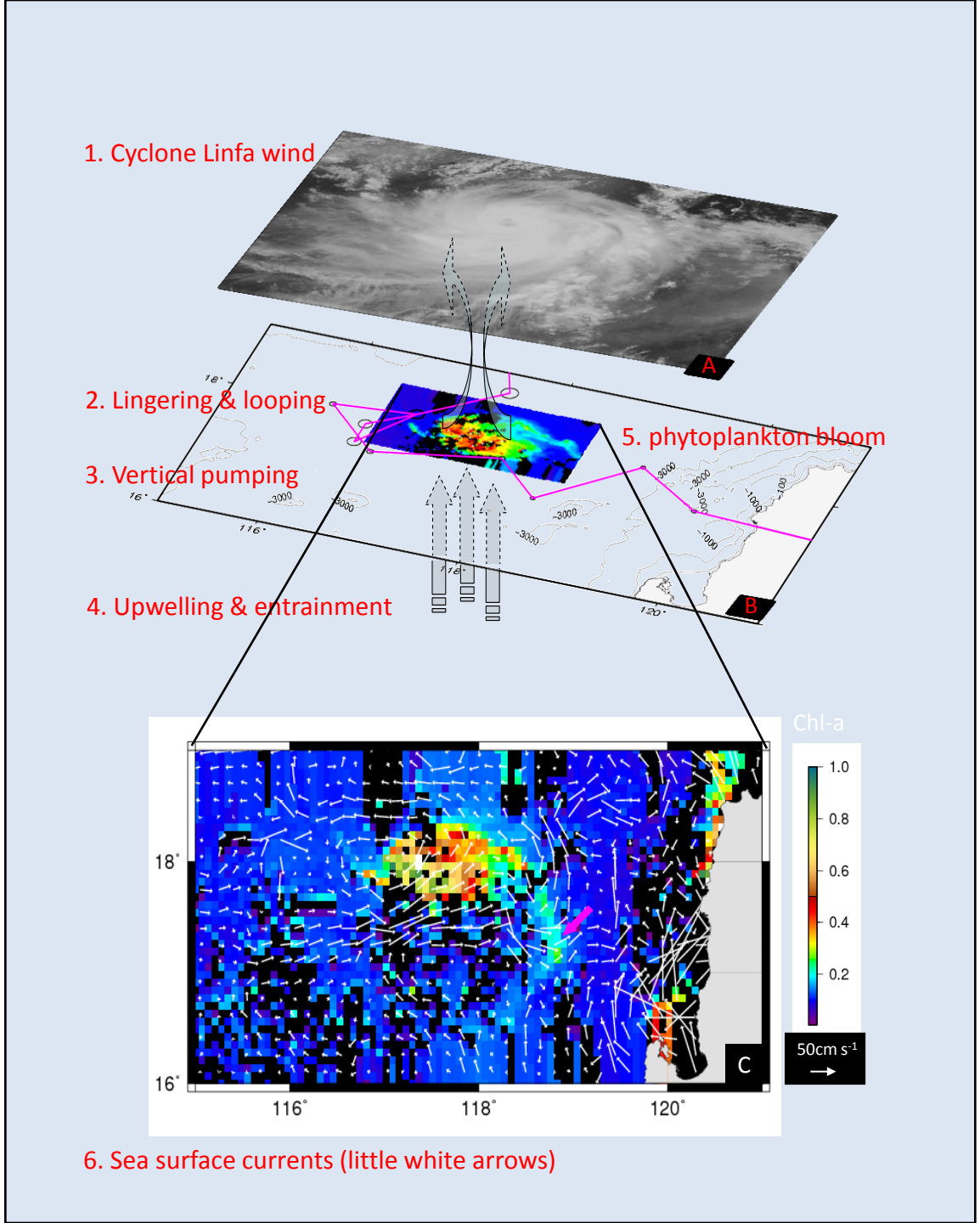
Eddy-feature phytoplankton bloom induced by tropical cyclone in the South China Sea,



(Chen & Tang, 2010,IJRS)


Prior Linfa
After or during Linfa
QuikScat wind vector
A1.7-13 Jun
A2.19 Jun
China
Taiwan
Luzon
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



能量传递

typhoon
Wind Pump
风泵

Chen, Tang , 2011, IJRS

Changes of Dissolved oxygen

(DO) after typhoon

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Advances in Space Research 53 (2014) 1081–1091

ADVANCES IN SPACE RESEARCH
(a COSPAR publication)

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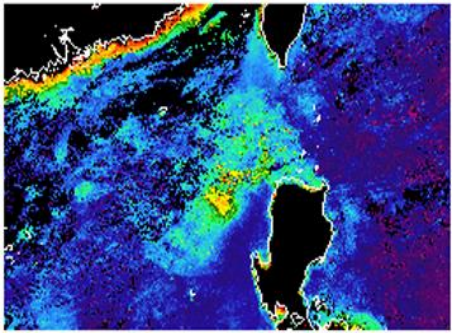
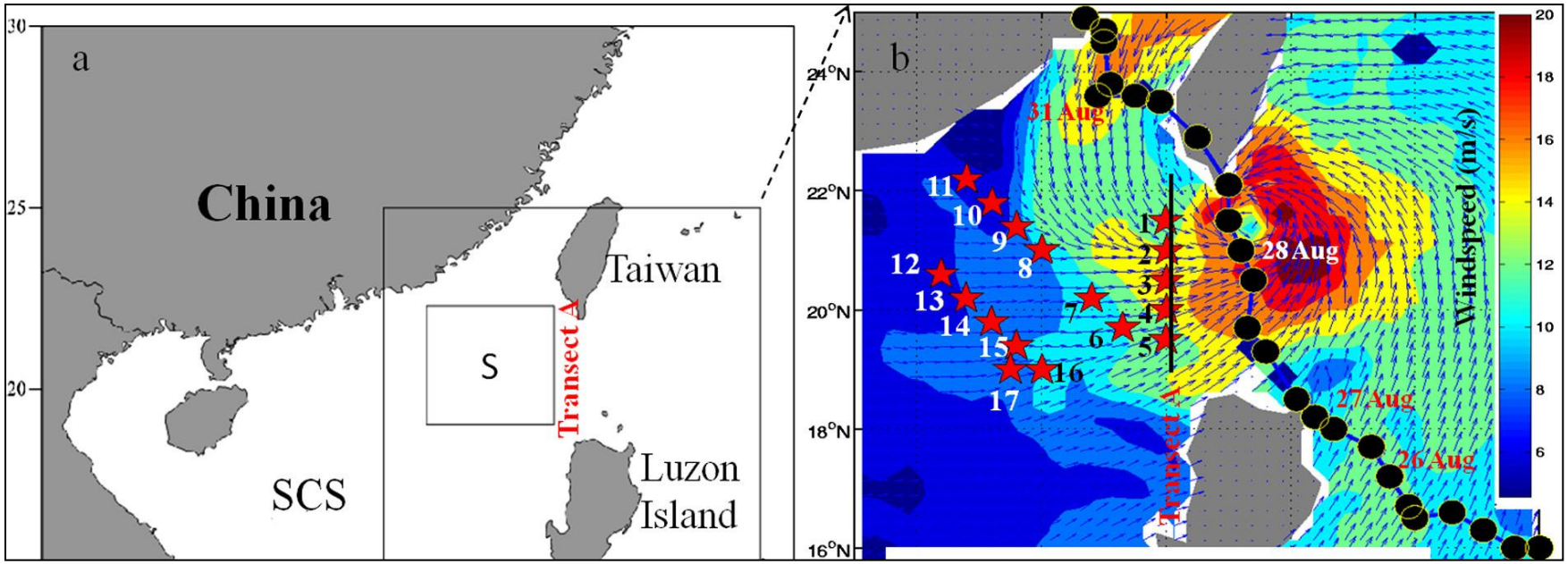
Response of dissolved oxygen and related marine ecological parameters to a tropical cyclone in the South China Sea

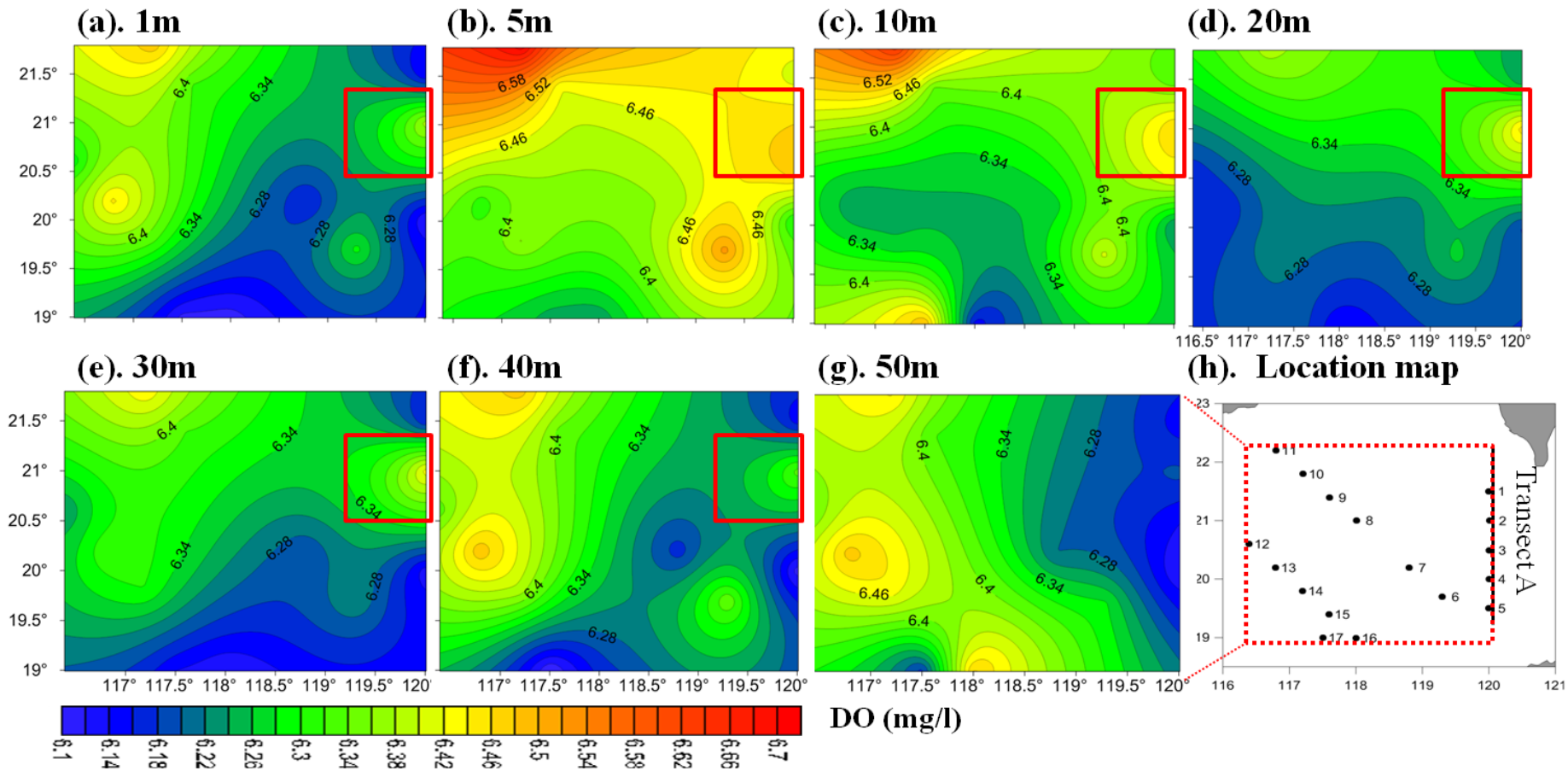
Jingrou Lin [a,b,c], Danling Tang [a,b,*], Werner Alpers [d], Sufen Wang [a]



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



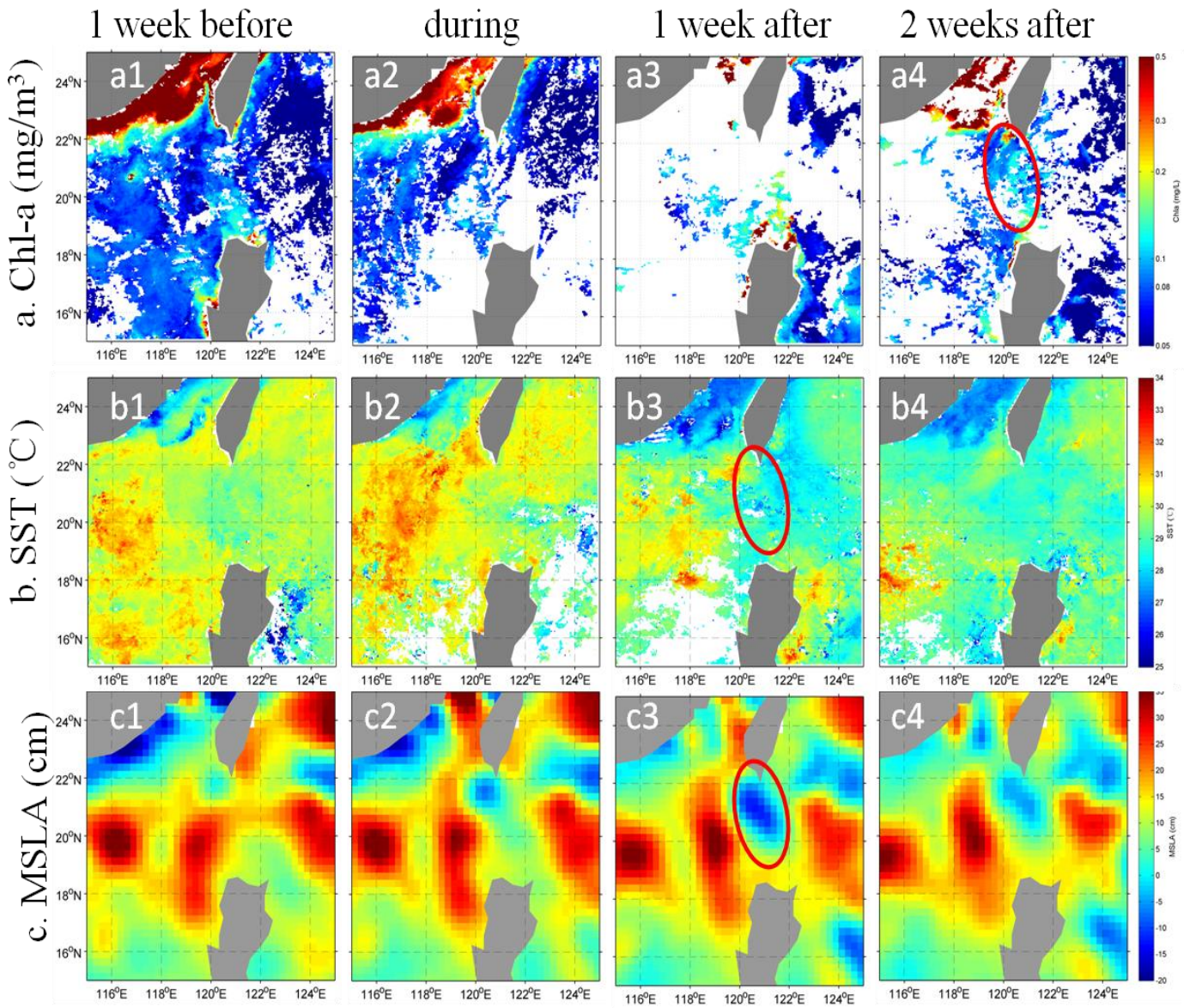
Horizontal distribution of DO concentration



(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)

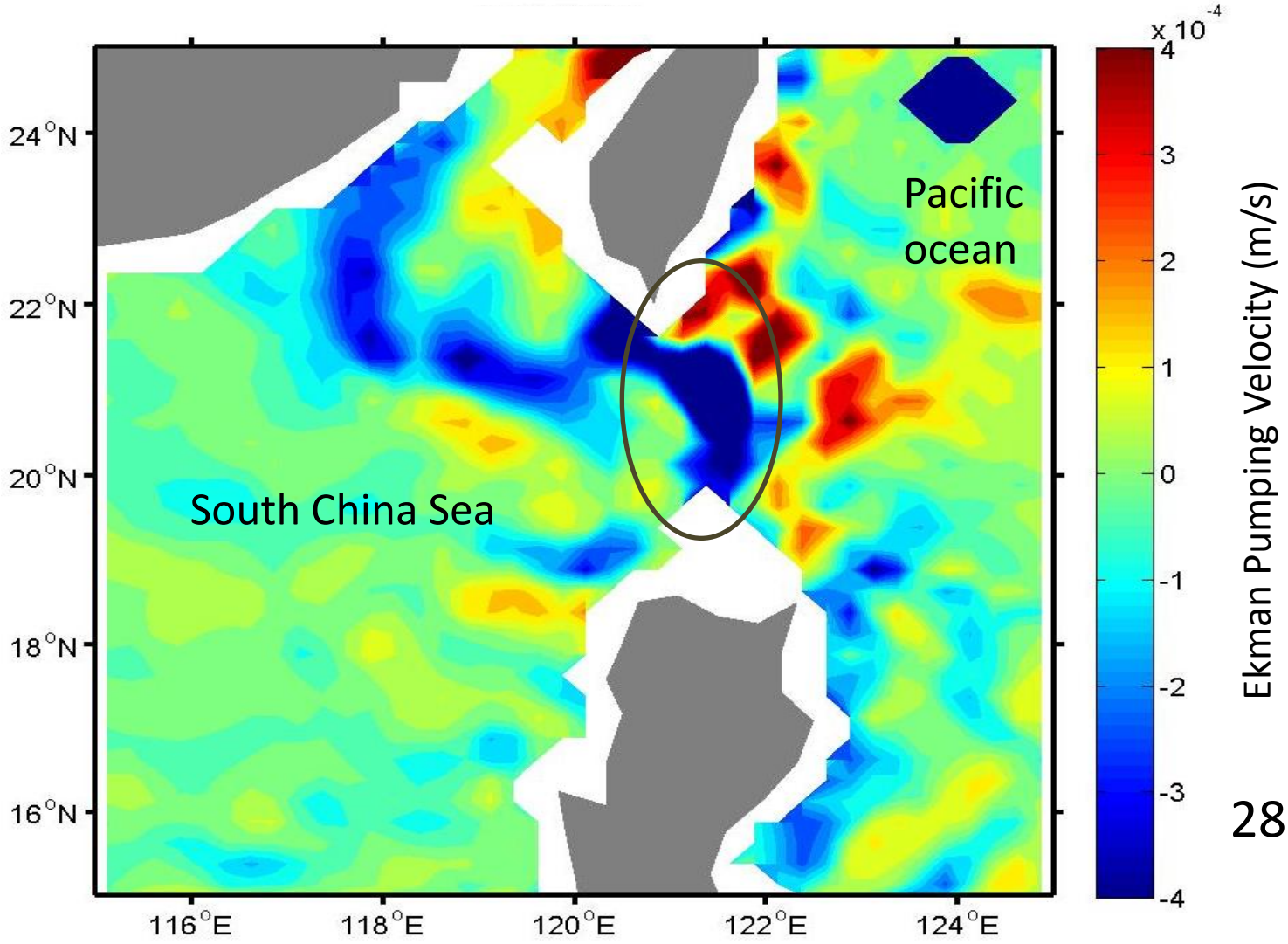
8-day composites retrieved from MODIS data

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),

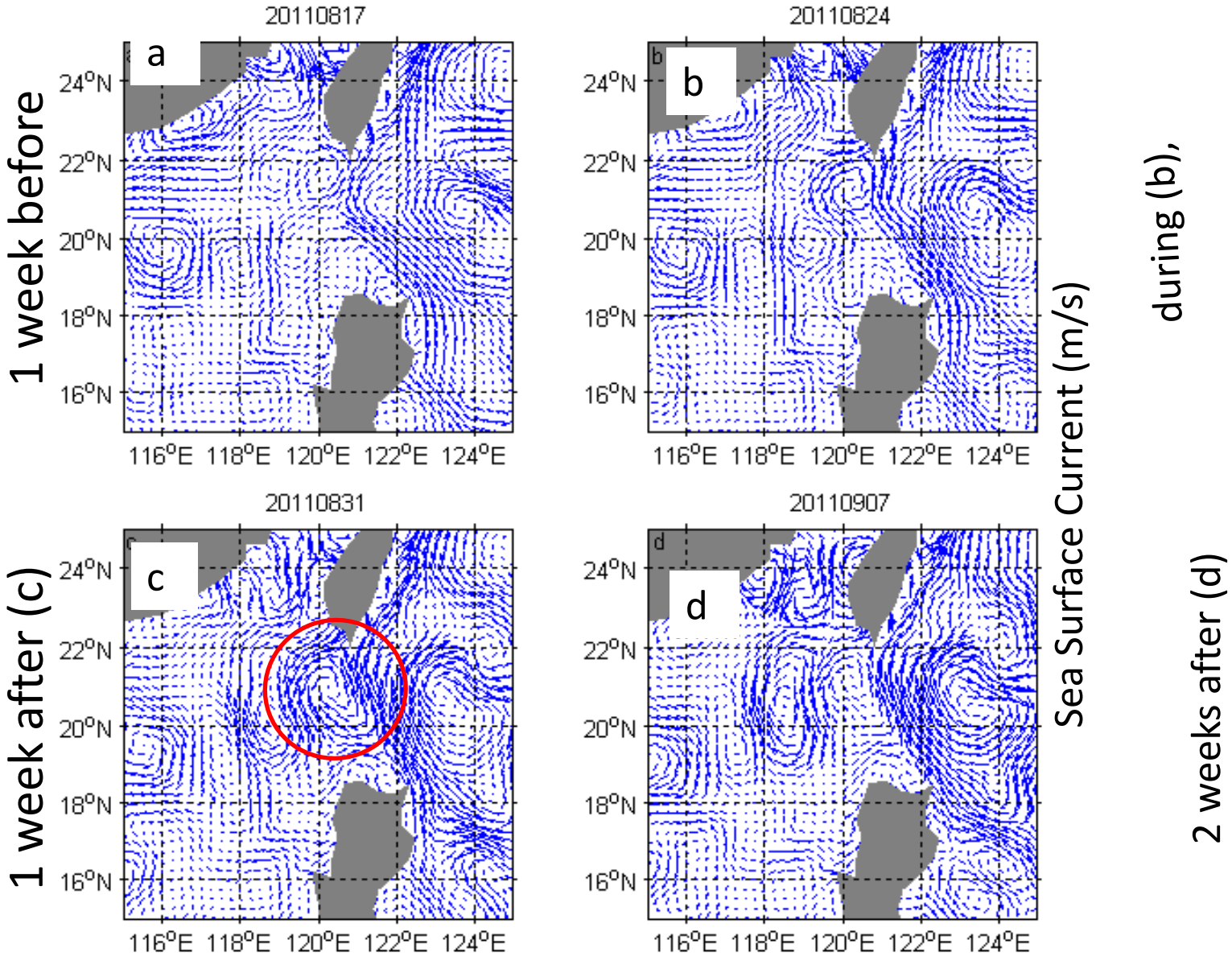


Fig.8

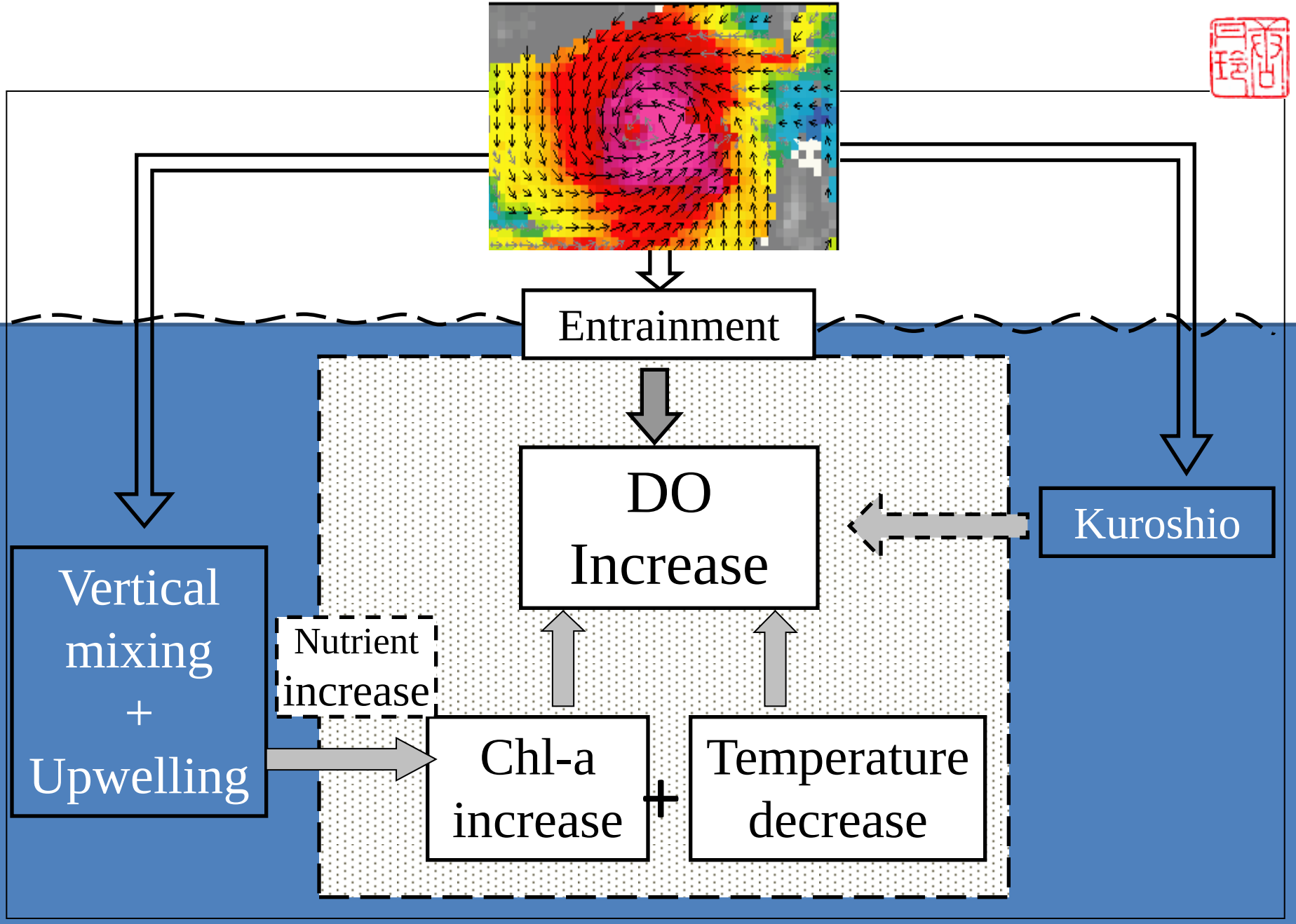

Entrainment
DO
Increase
Kuroshio
Vertical
mixing
+
Upwelling
Nutrient
increase
Chl-a
increase
+
Temperature
decrease

Fig.9

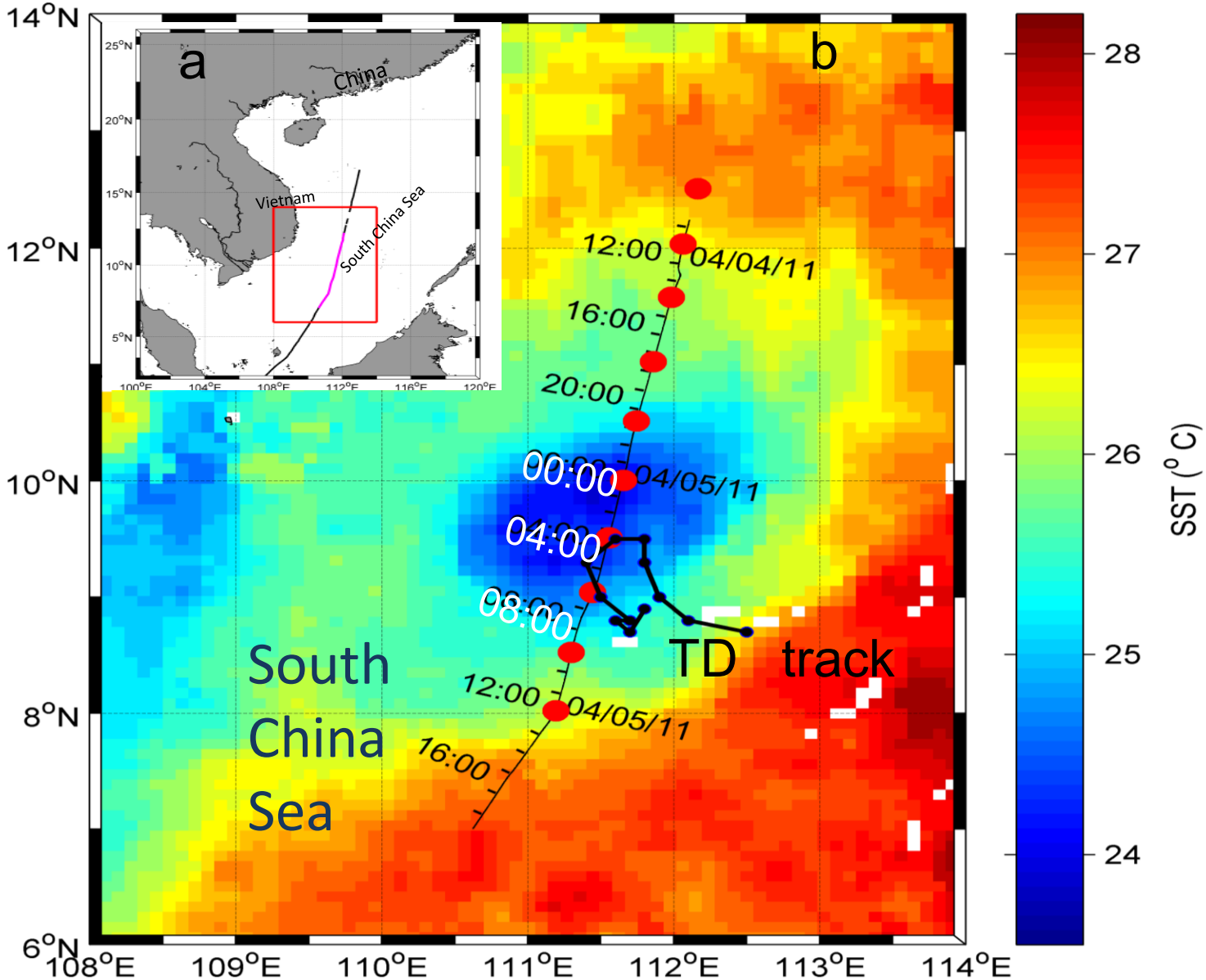
Enhanced sea-air CO_2 exchange

influenced by a tropical depression in the South China Sea

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

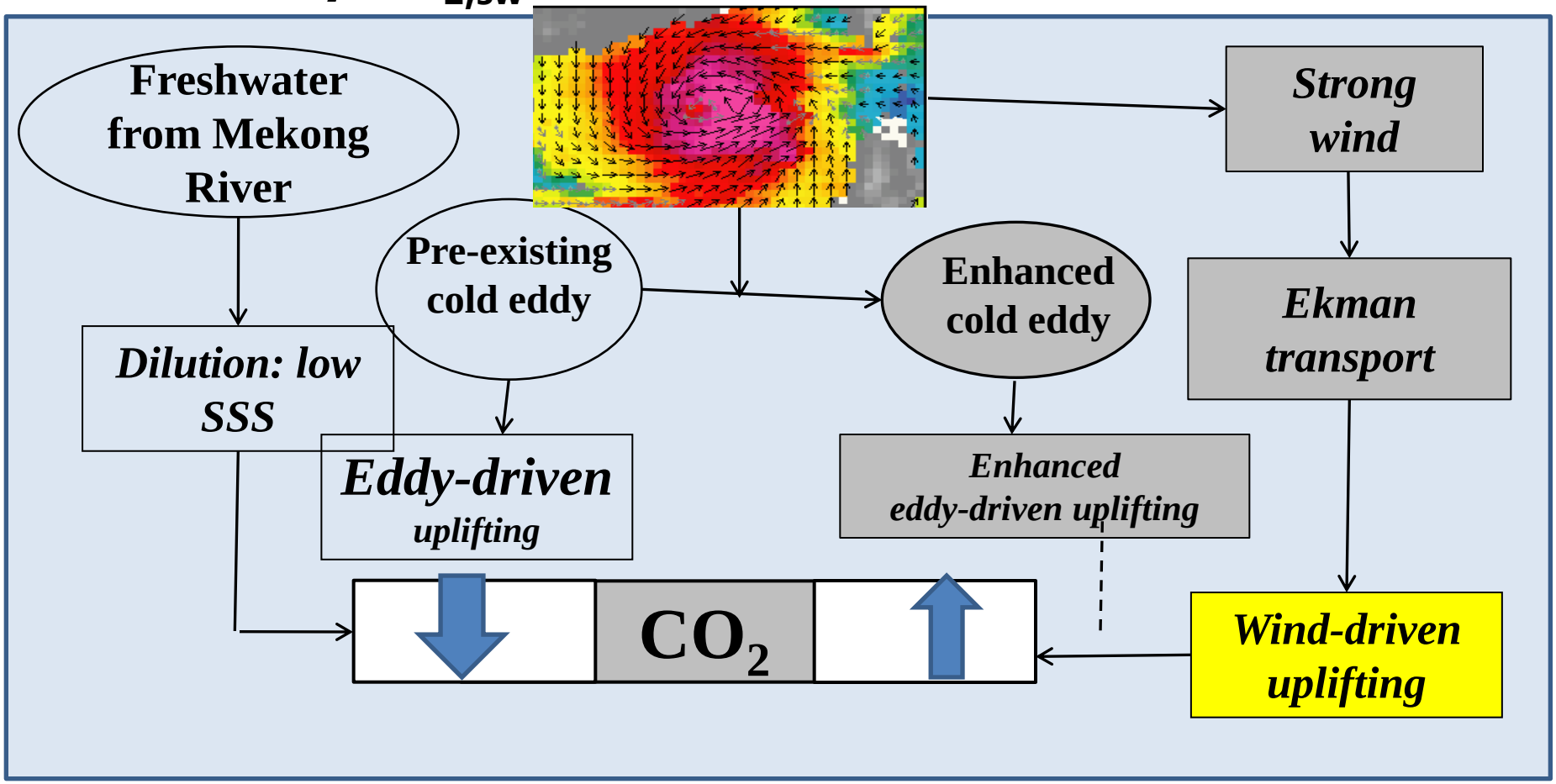
A tropical depression (TD) in the SCS

April 2011



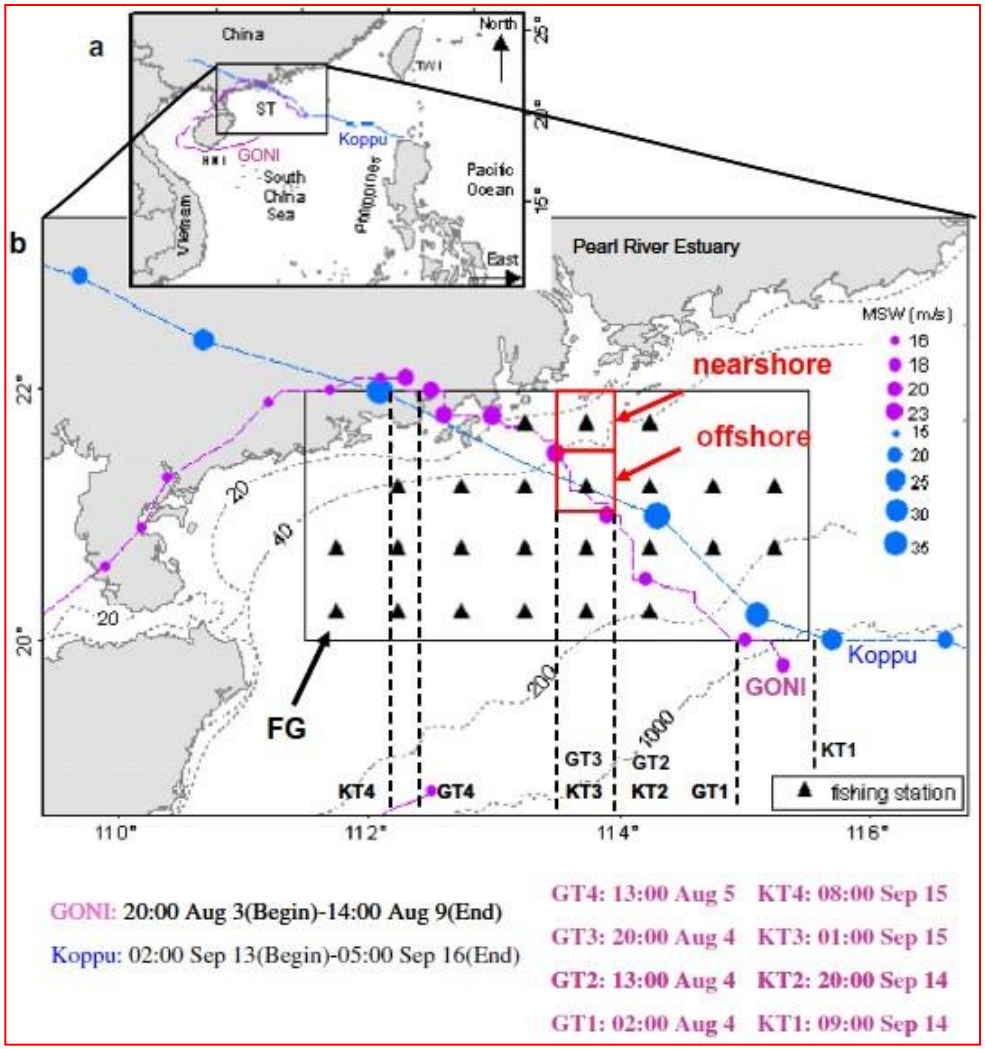
1. Surface water diluted by heavy rain, with low $pCO_{2,sw}$

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



change to a source temporarily

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



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	√		√						√		√	√	√	√	√		
s16	√		√						√	o	√	√	√				√
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

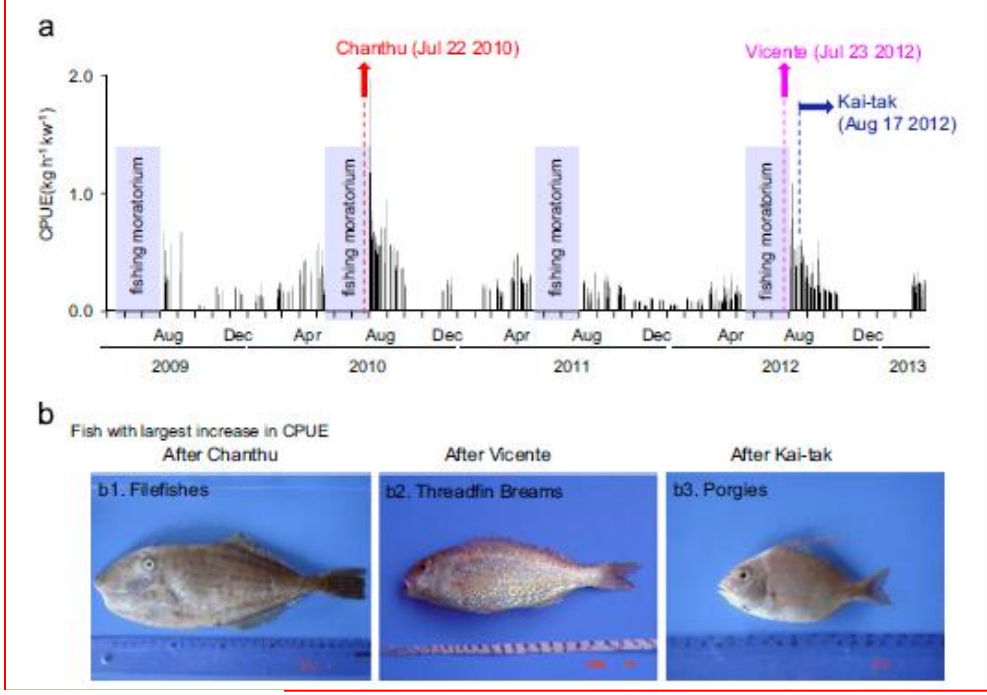
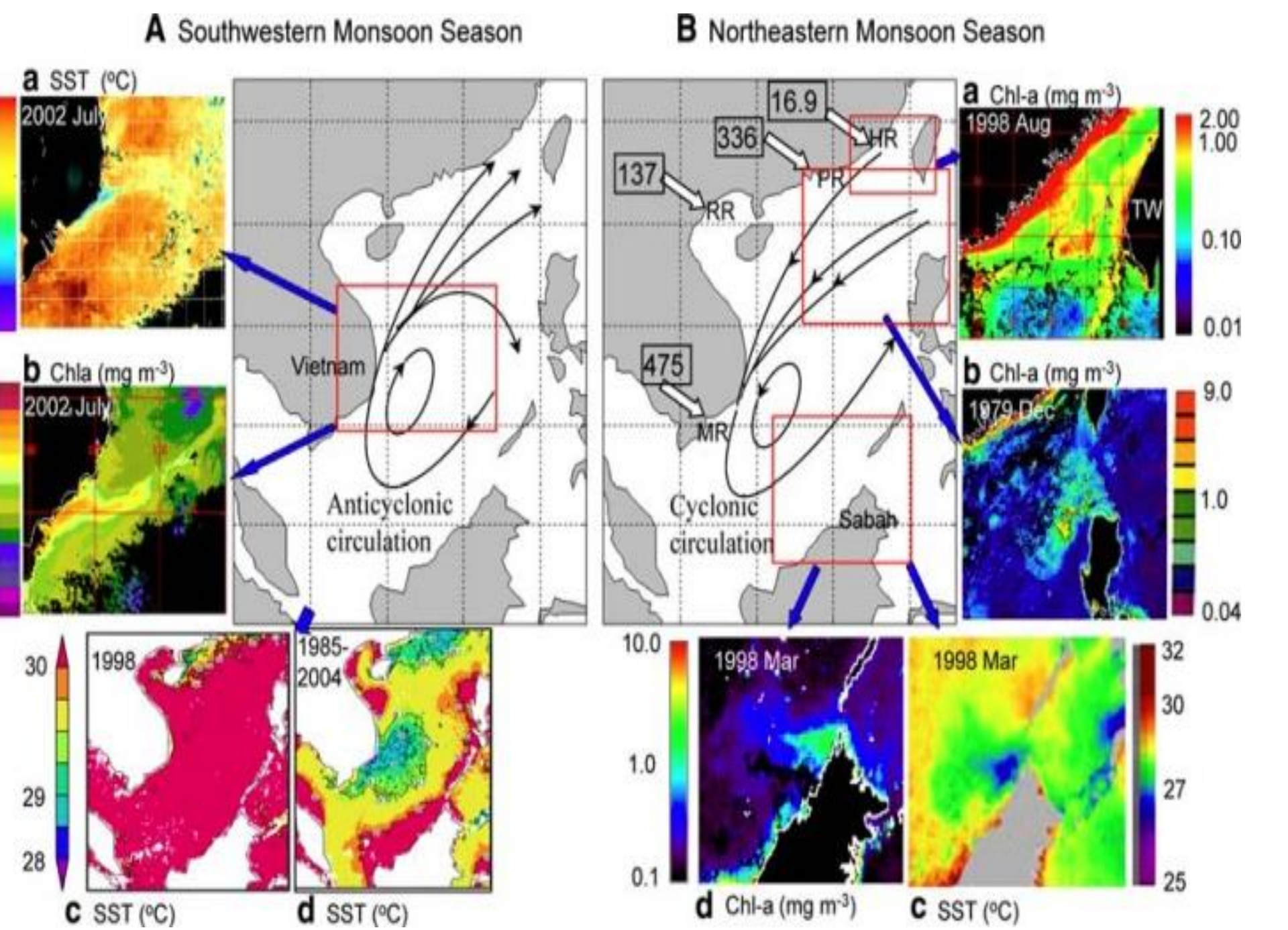
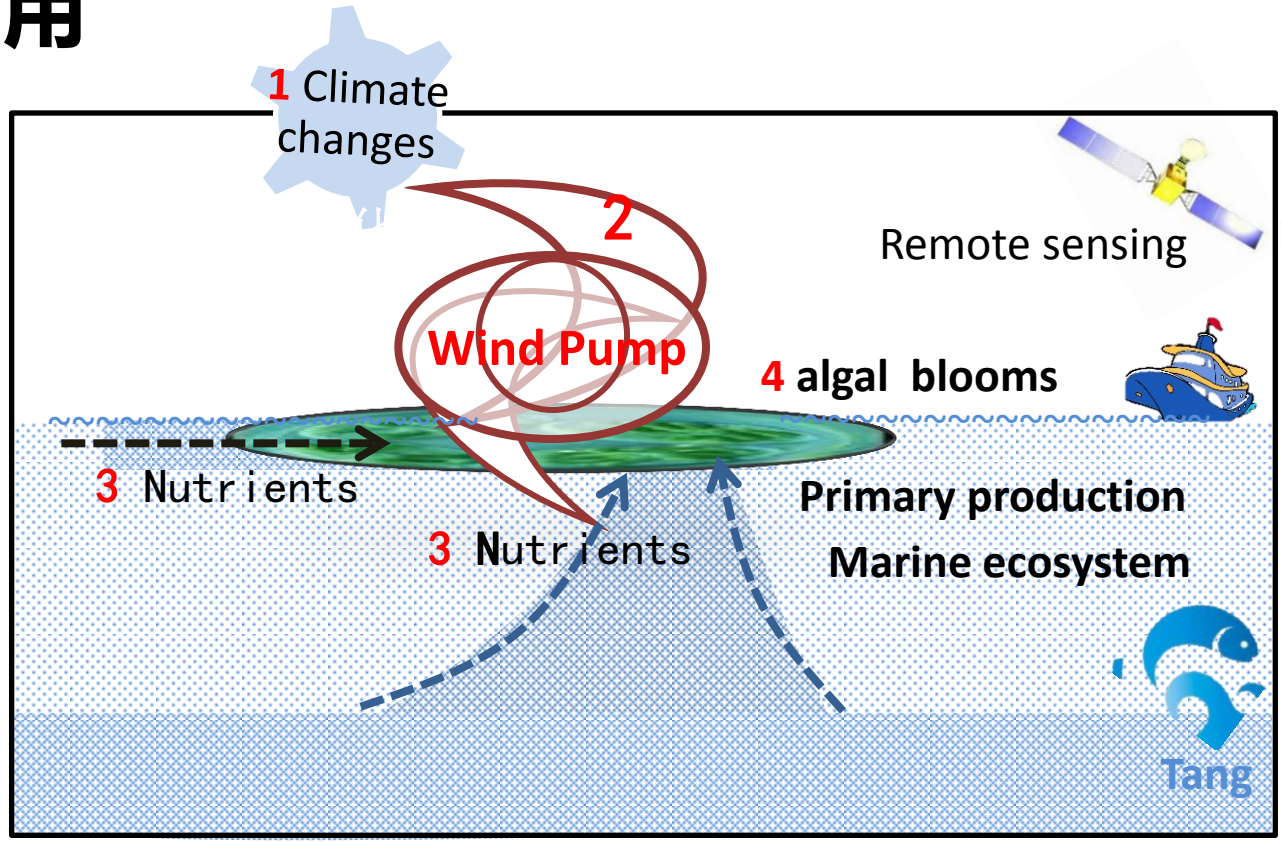


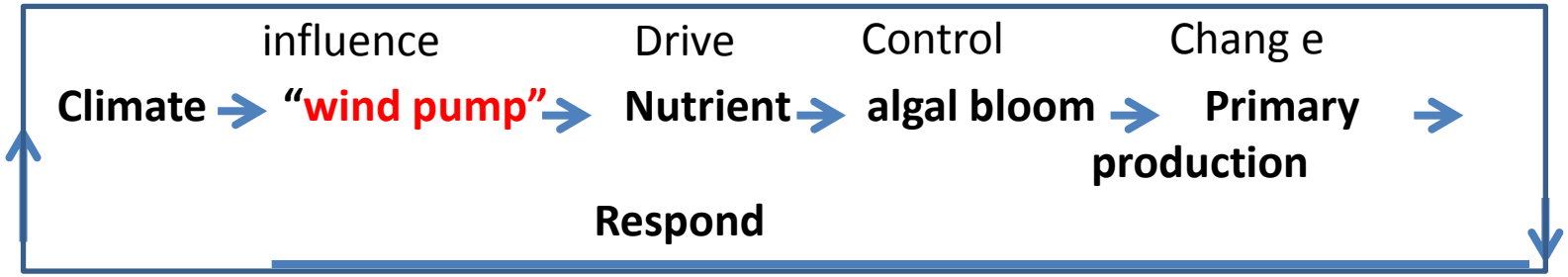
Table 1
Information of 30 main fishes sampled in the area.

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


A Southwestern Monsoon Season
B Northeastern Monsoon Season
a SST (°C)
2002 July
b Chla (mg m-3)
2002 July
Vietnam
Anticyclonic circulation
30
29
28
1998
1985-2004
c SST (°C)
d SST (°C)
16.9
336
137
475
HR
PR
RR
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
d Chl-a (mg m-3)
1998 Mar
32
30
27
25
c SST (°C)

风泵作用

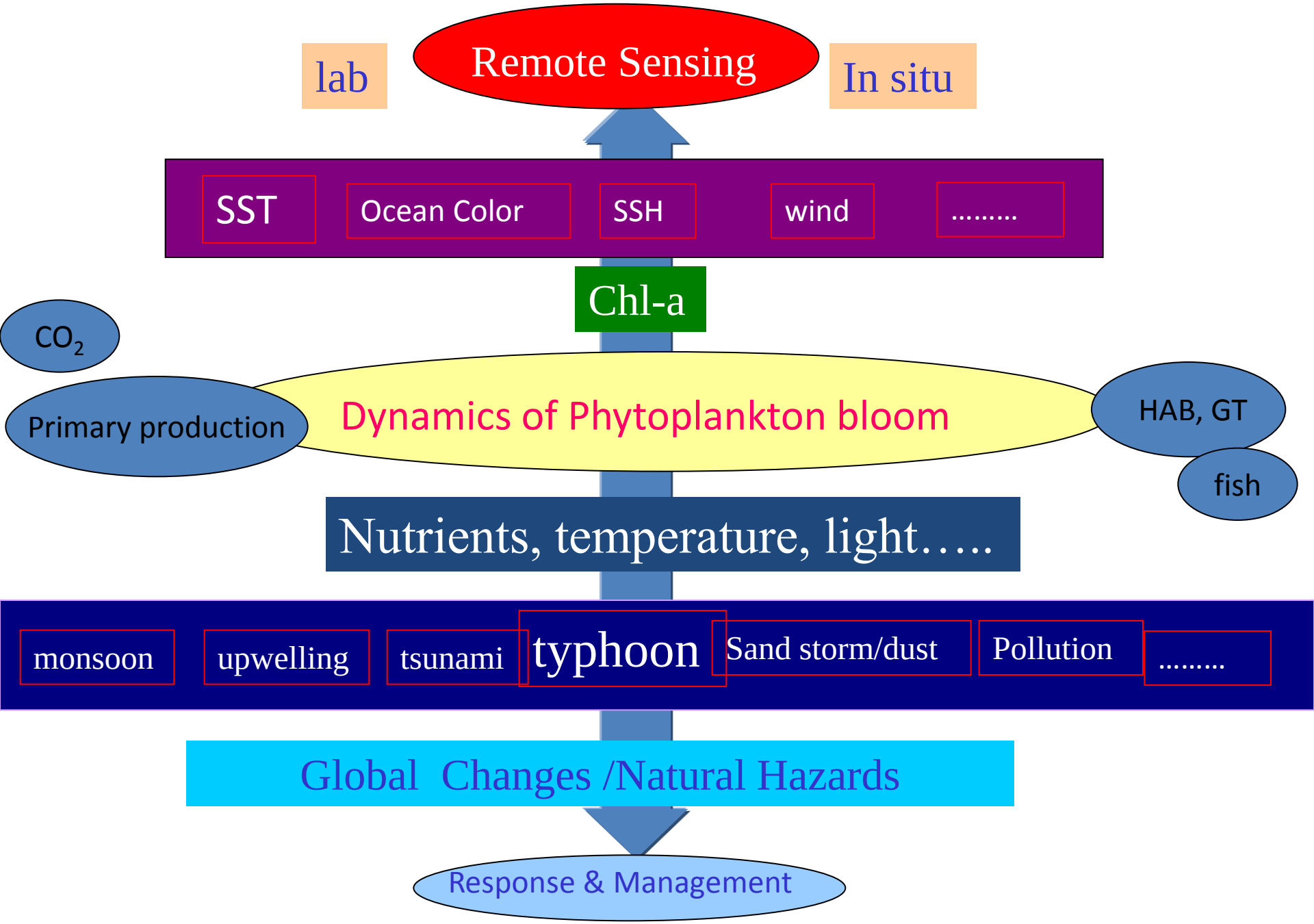




Wind driven algal bloom in the open oceans

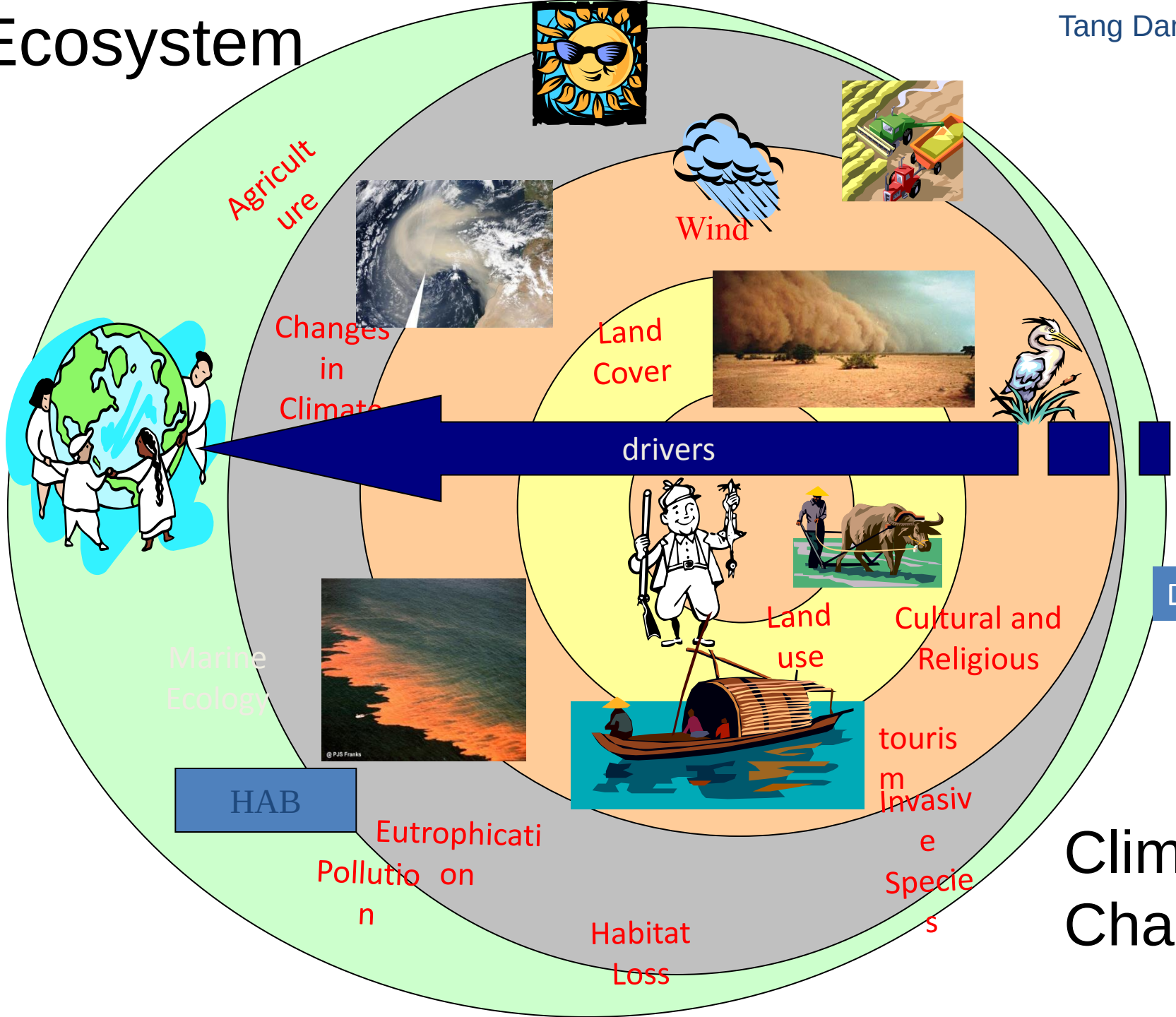
4

Remote sensing of marine ecology


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

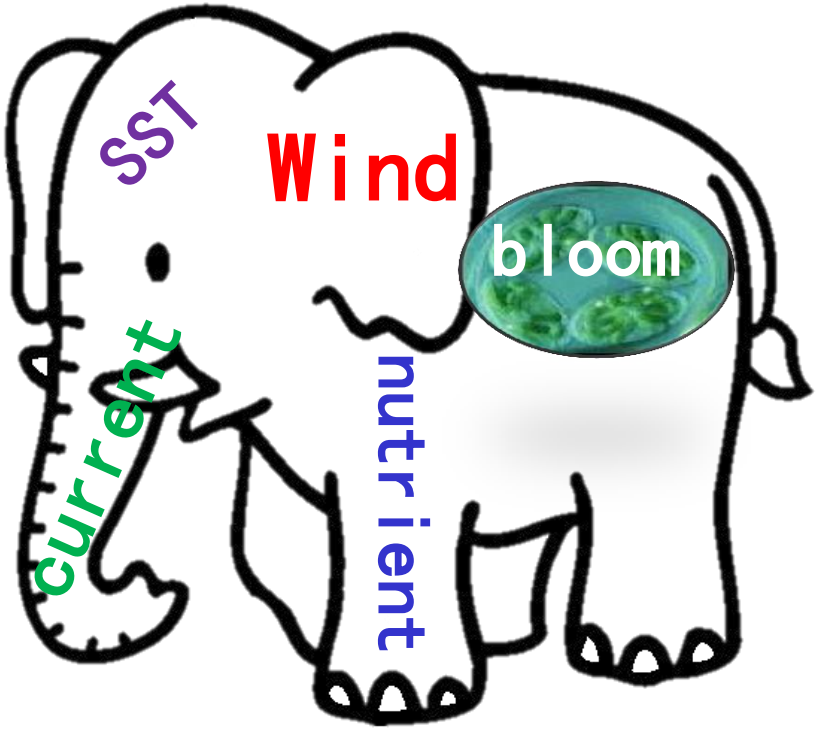
Tang DanLing 唐丹

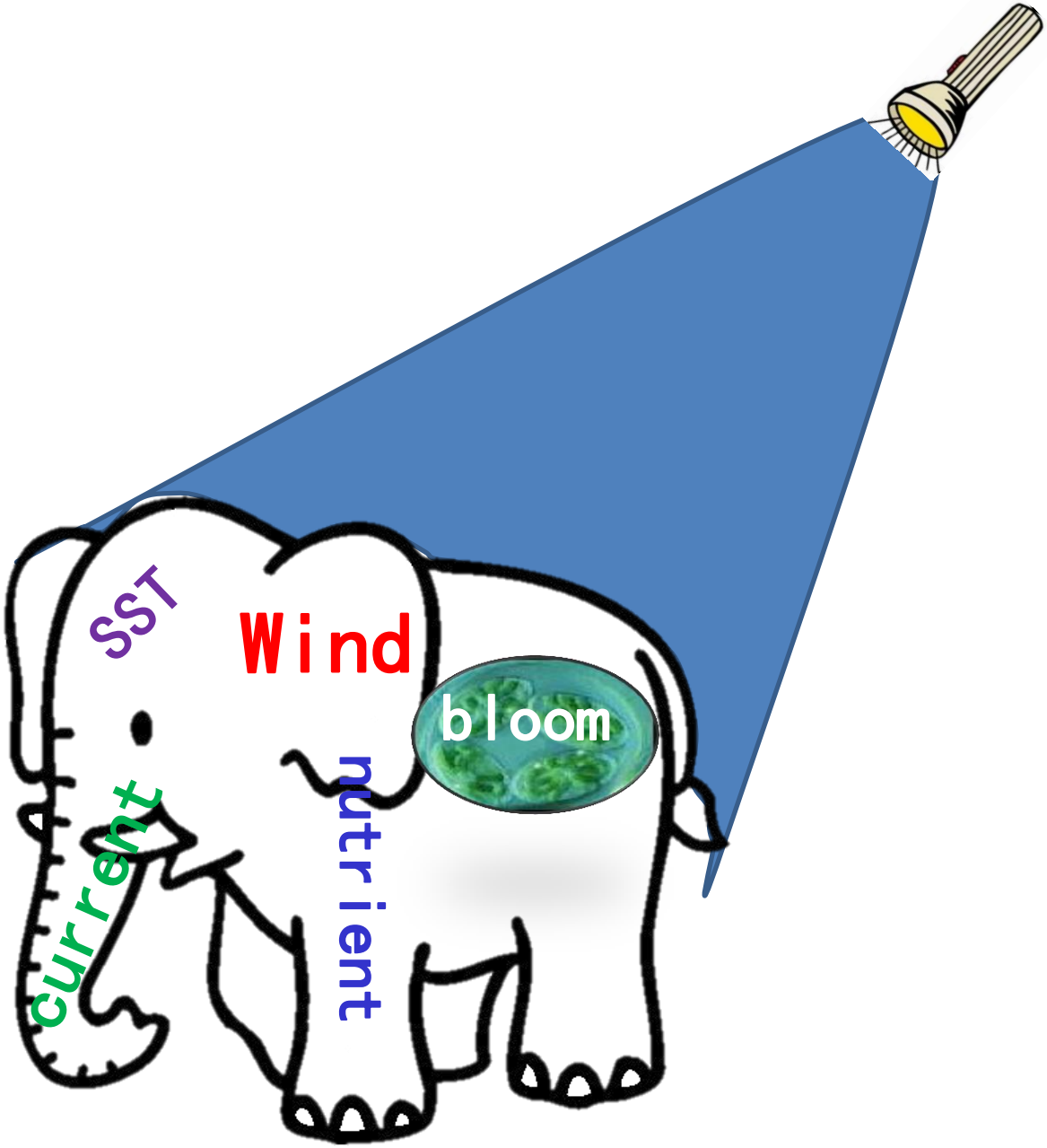


Climate Changs

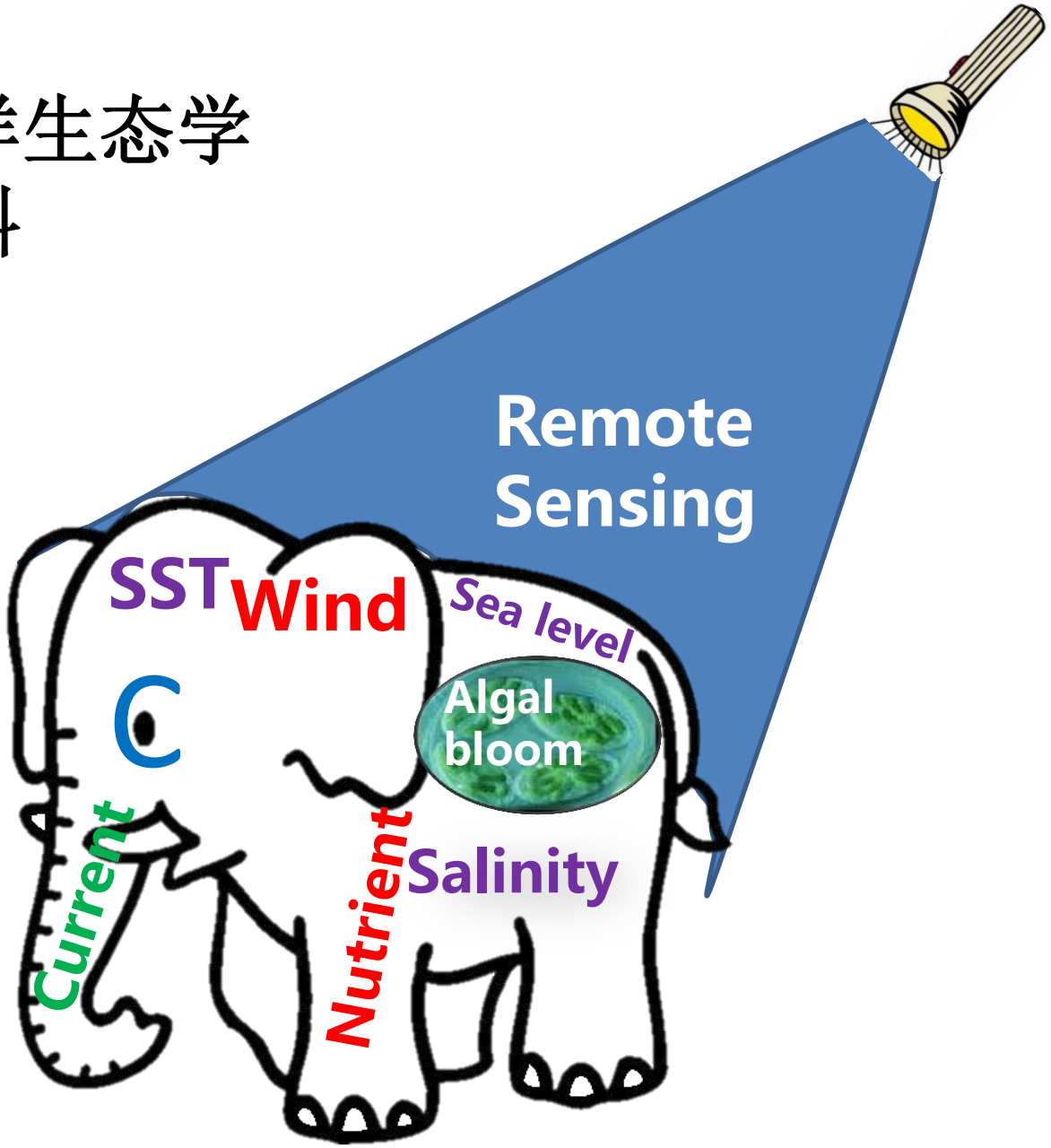
- Multi –
- channel
- Sensors
- Satellite
- Access
- ….people

Pan Ocean Remote Sensing


SST
Wind
bloom
current
nutrient


SST
Wind
bloom
current
nutrient

遥感海洋生态学
交叉学科



Remote Sensing of Marine Ecology

Ocean remote sensing – ocean science -Milestone。

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

Milestone

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

“Remote sensing of Marine Ecology

Welcome to

13rd PORSEC

3 – 11 Nov 2016 ,
Fortaleza, Ceará, Brazil

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March， 2017,
Zhoushang， China

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浙江大学 ZHEJIANG UNIVERSITY

中国科学院南海海洋研究所 SOUTH CHINA SEA INSTITUTE OF OCEANOLOGY CHINESE ACADEMY O

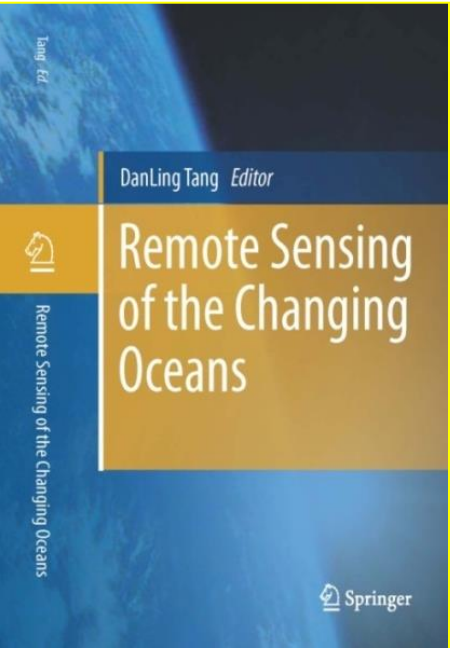
DanLing TANG (lingzis)

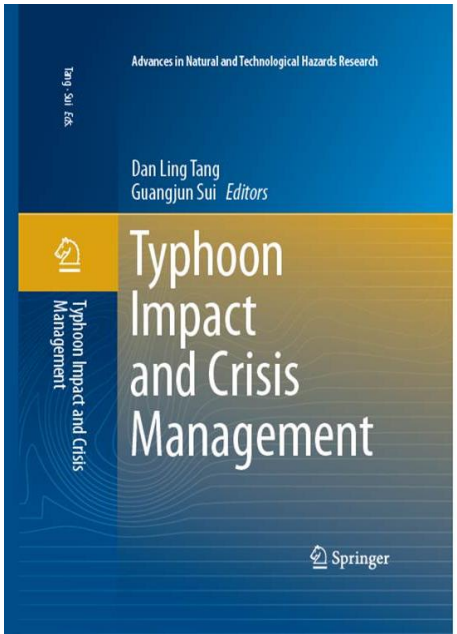
Thank You!

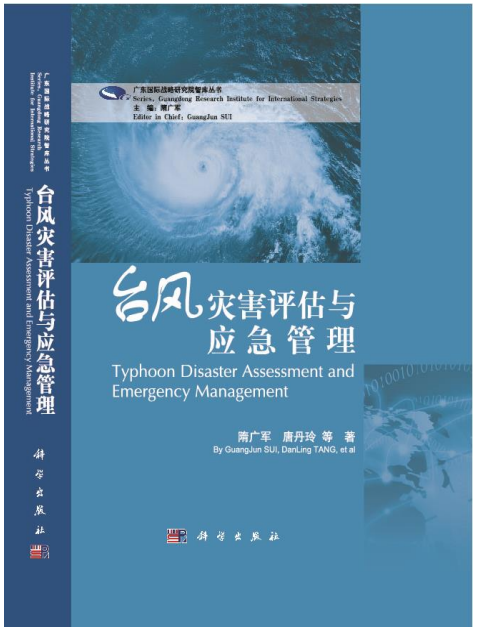
Springer
the language of science

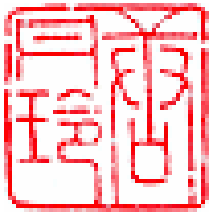
South China Sea Institute of Oceanology

Chinese Academy of Sciences







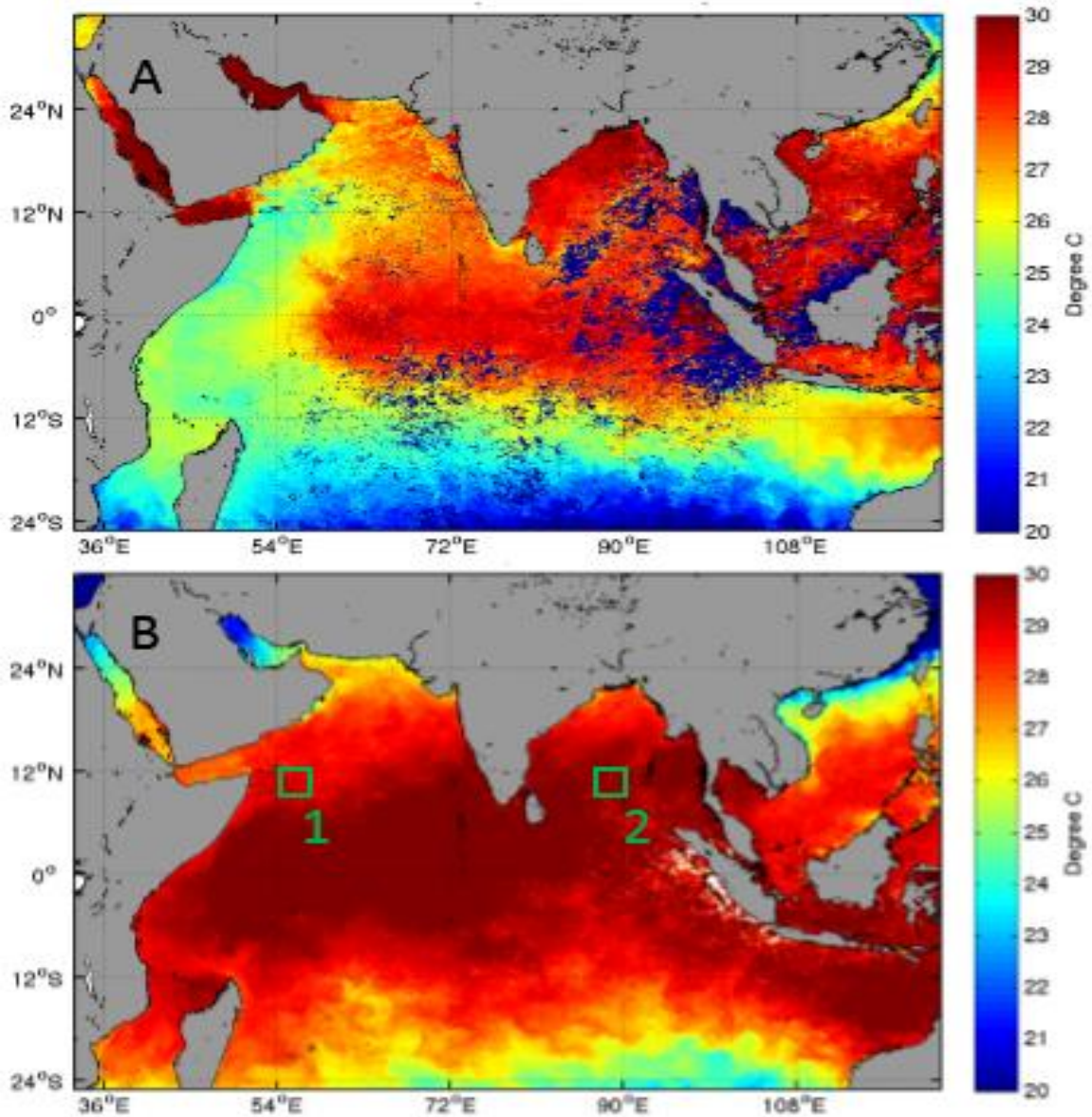


3

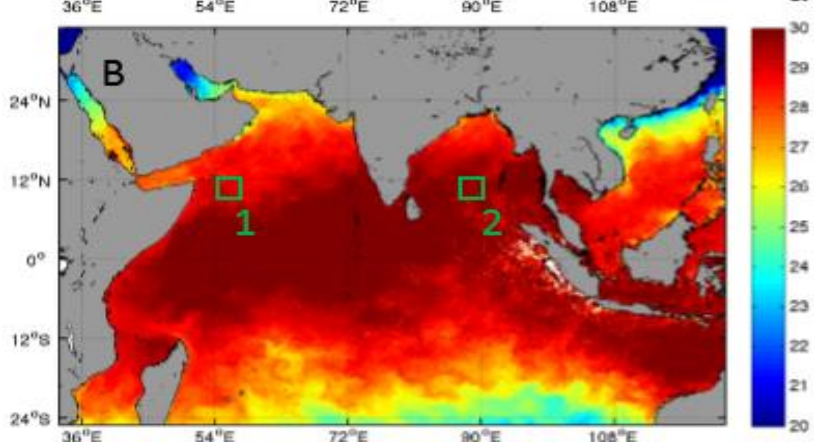
丝绸之路的海洋遥感

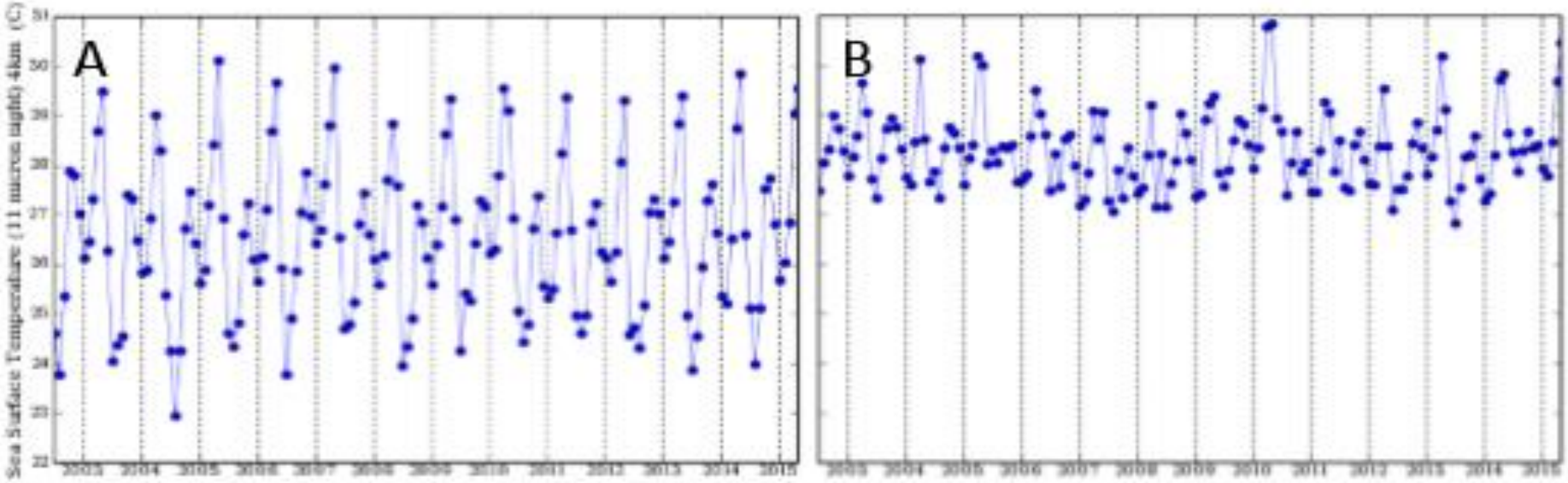
Available satellite remote sensing

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

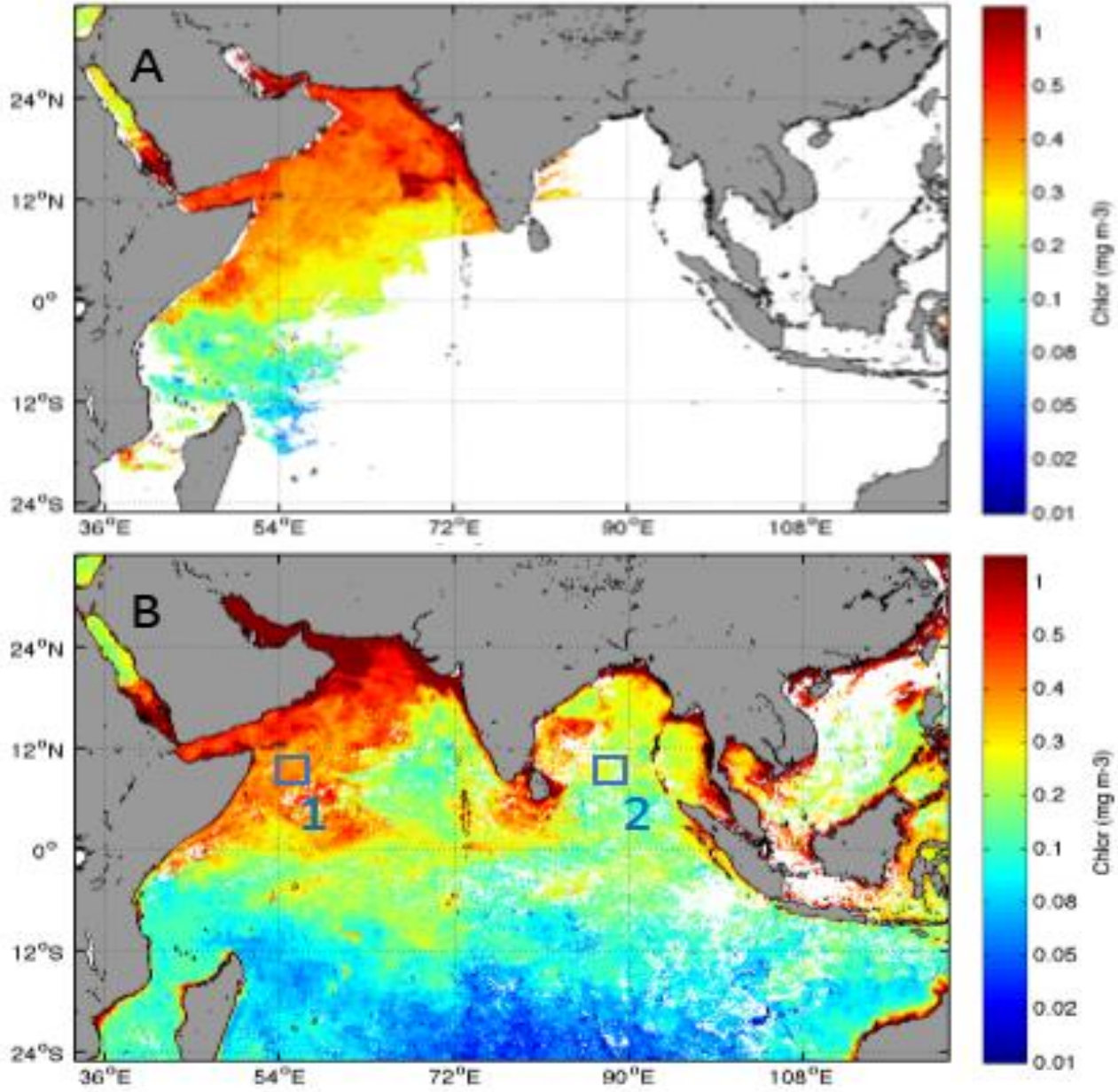


Monthly averaged SST data in different time. (A) SST derived from the AVHRR sensor onboard the satellite NOAA-7 in September 1981, and (B) SST derived from the MODIS sensor onboard the satellite Aqua in April 2015.

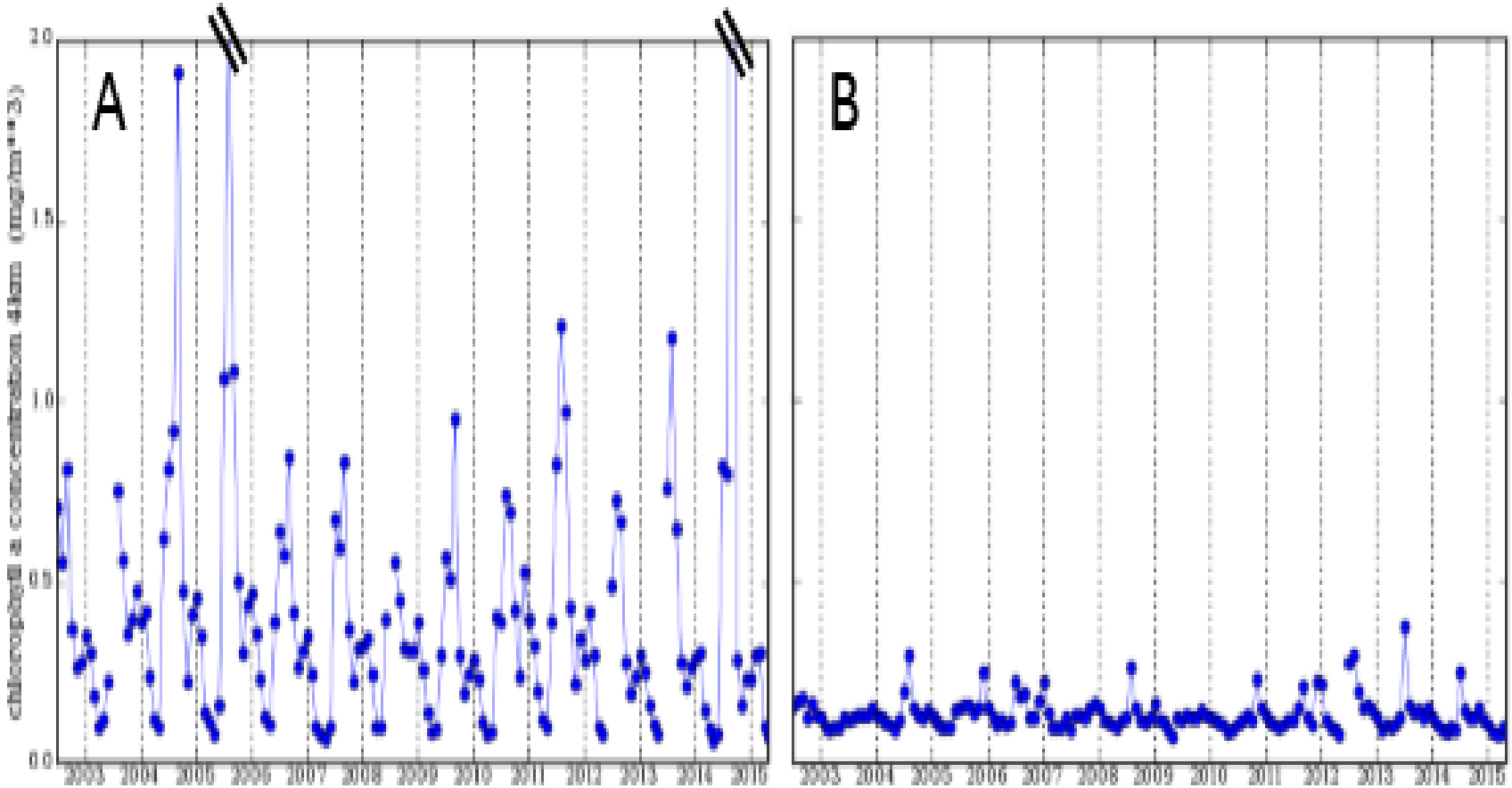




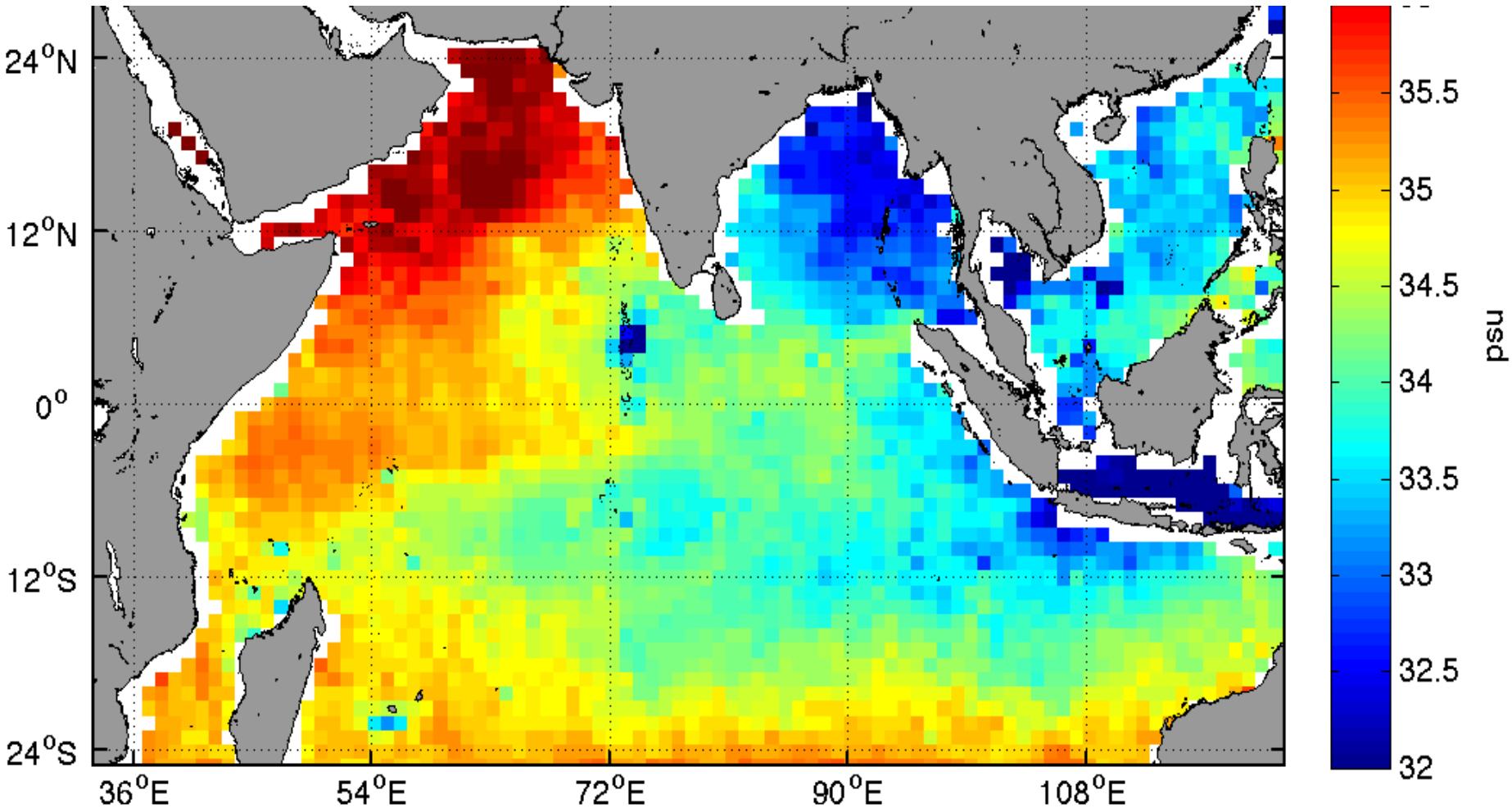
Area-averaged time series MODIS/Aqua night SST 4km resolution during Jul 2002 – May 2015



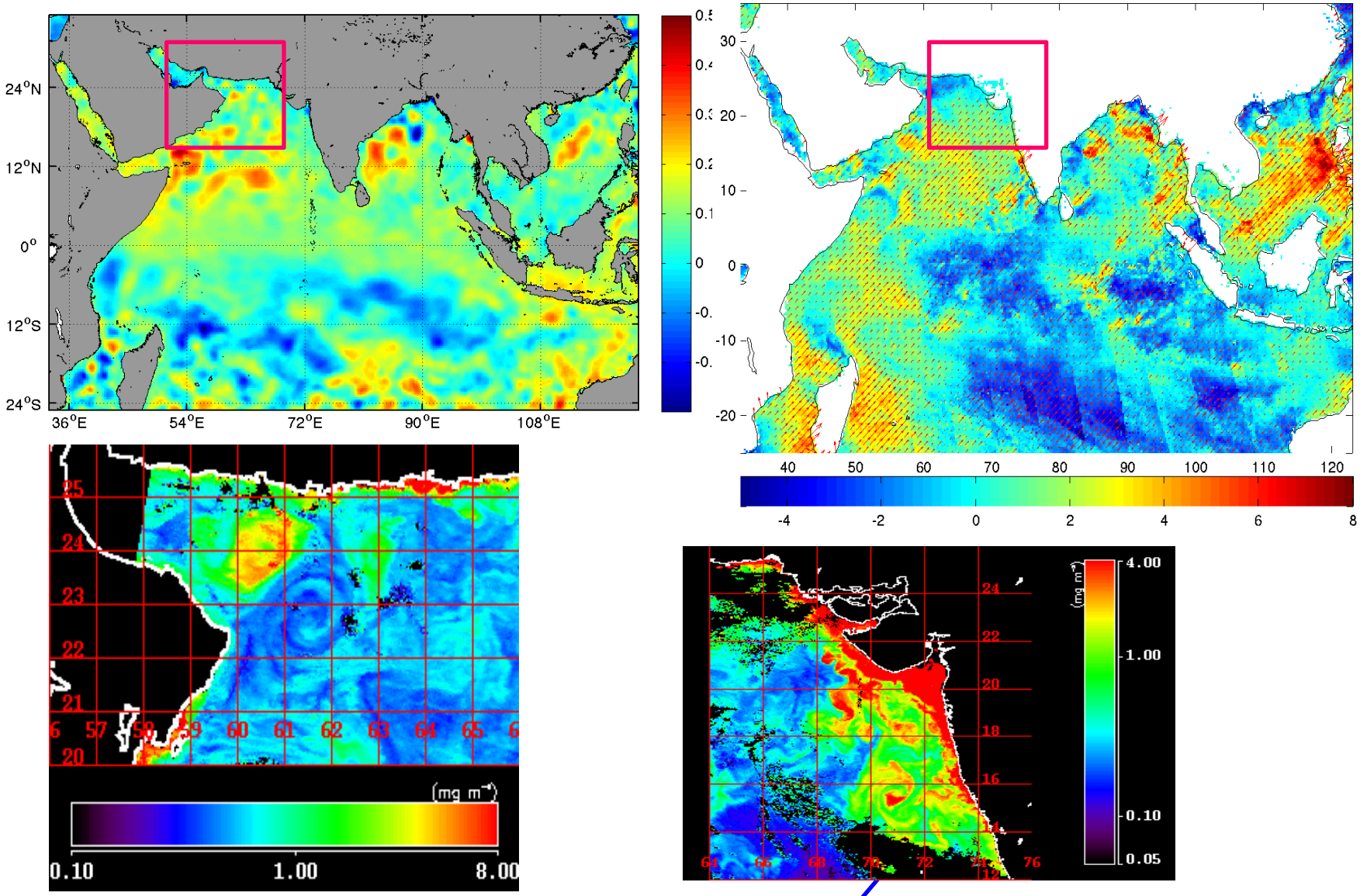
Monthly averaged Chlorophyll concentration in December in different year. (A) Chl derived from CZCS data in 1978, and (B) Chl derived from MODIS/Aqua in 2014.



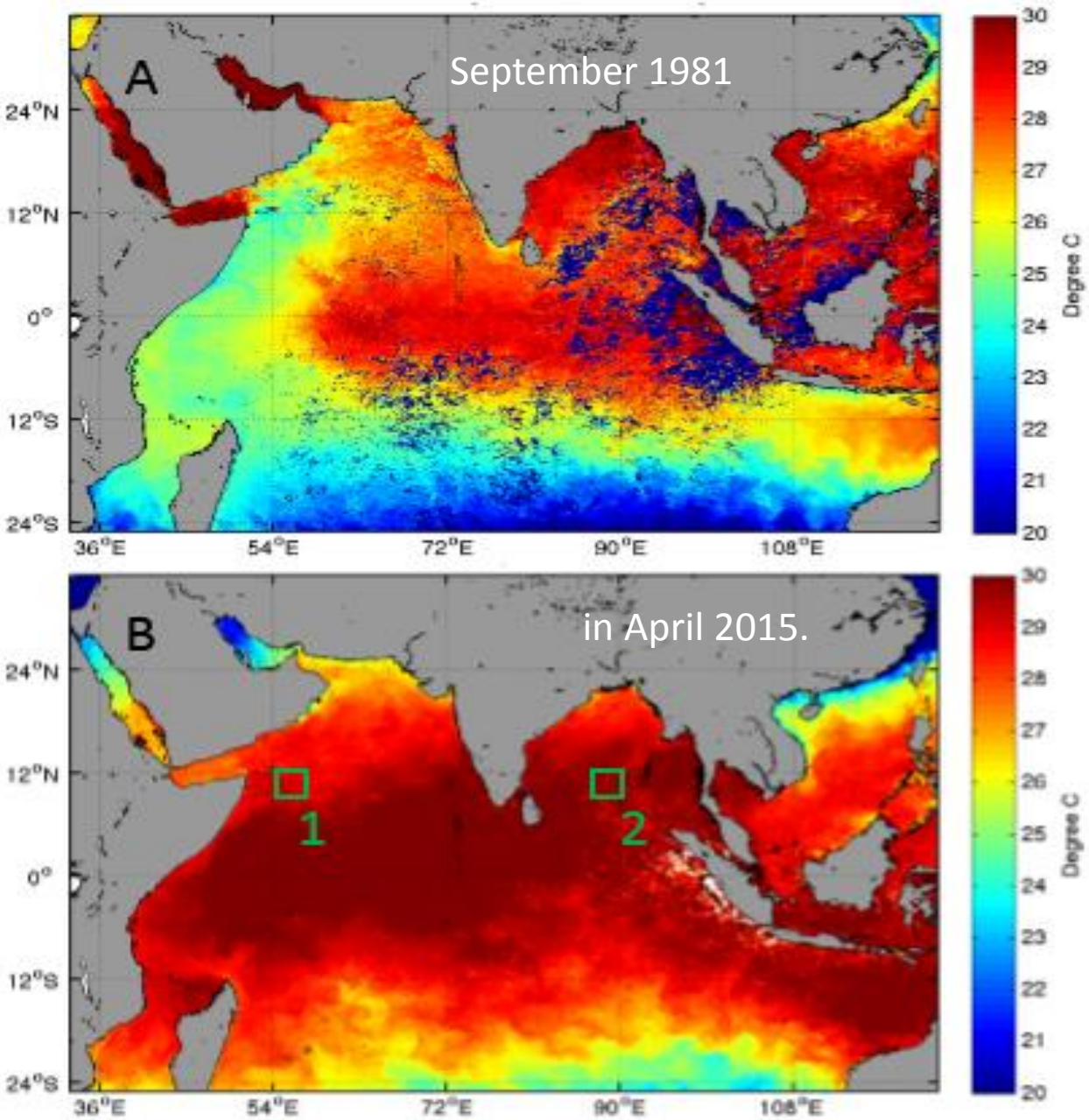
Area-averaged time series MODIS/Aqua Chlorophyll 4km resolution during Jul 2002 – May 2015. Region 54-57E, 9-12N (A), and region 87-90E, 9-12N (B), which corresponding to the blue boxes 1 and 2 in Fig. 4B, respectively.



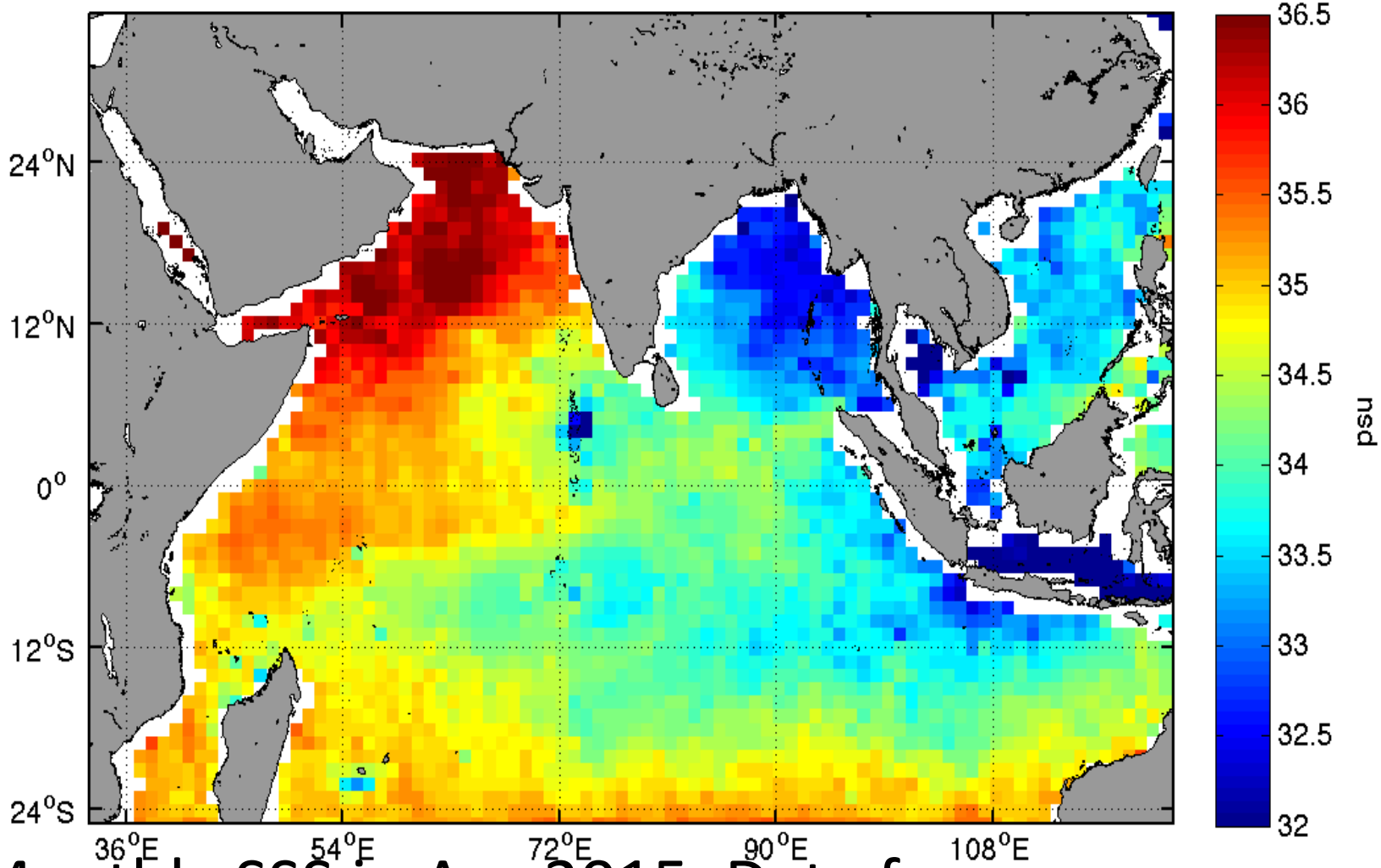
Monthly SSS in Apr 2015. Data from http://oceancolor.gsfc.nasa.gov/cgi/l3



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
30
29
28
27
26
25
24
23
22
21
20
Degree C

SST data

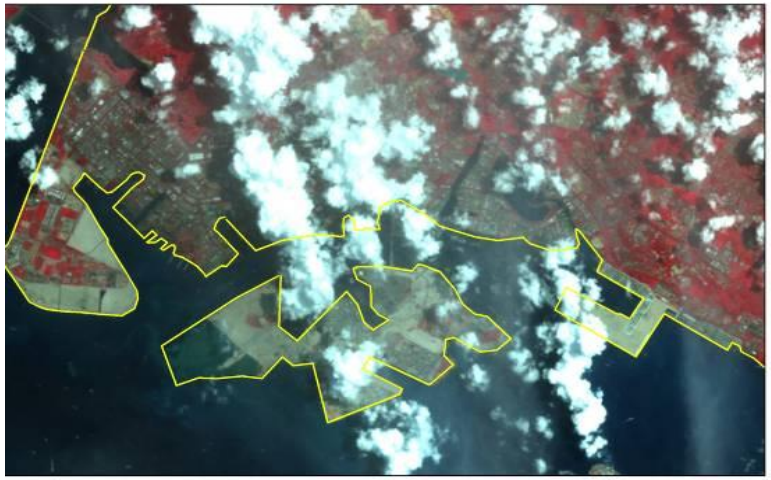


Monthly SSS in Apr 2015. Data from http://oceancolor.gsfc.nasa.gov/cgi/l3

Coastline monitoring

Landsat MSS， 1973/10/17

Landsat TM， 1989/08/20

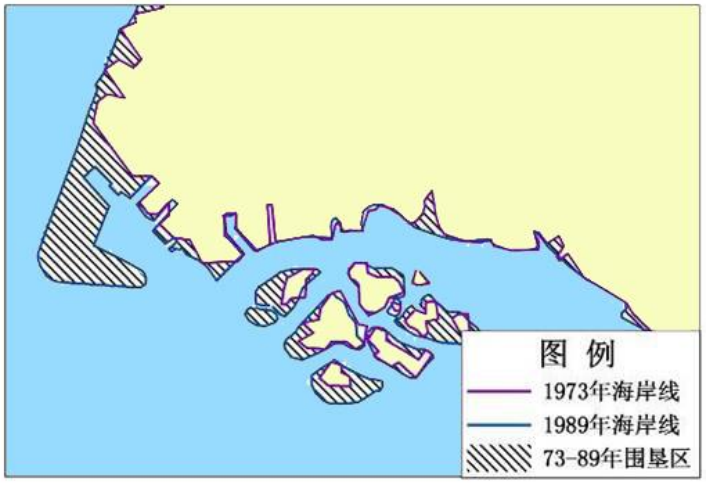


Landsat ETM+， 1999/09/01

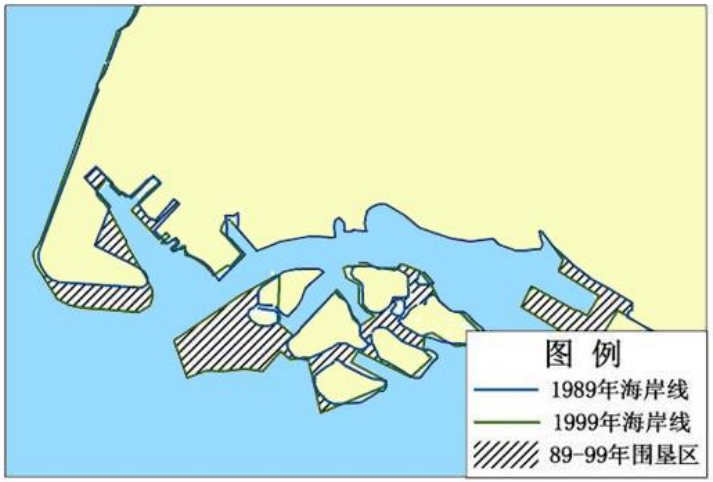
Landsat ETM+， 2002/04/02

Coastline monitoring in the southwest of Singapore.

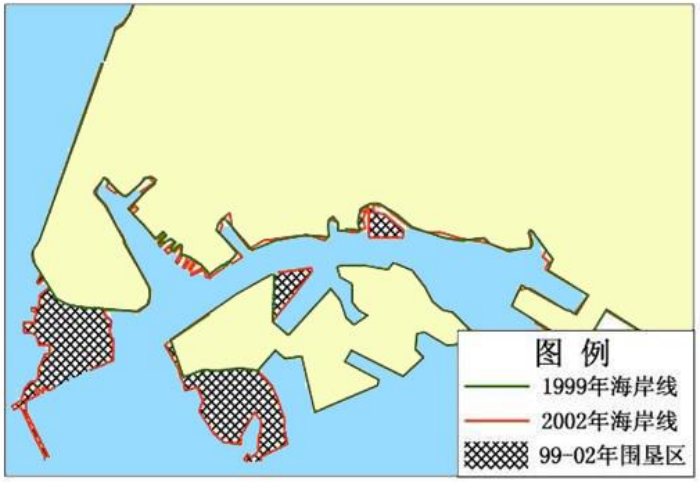
Coastline monitoring



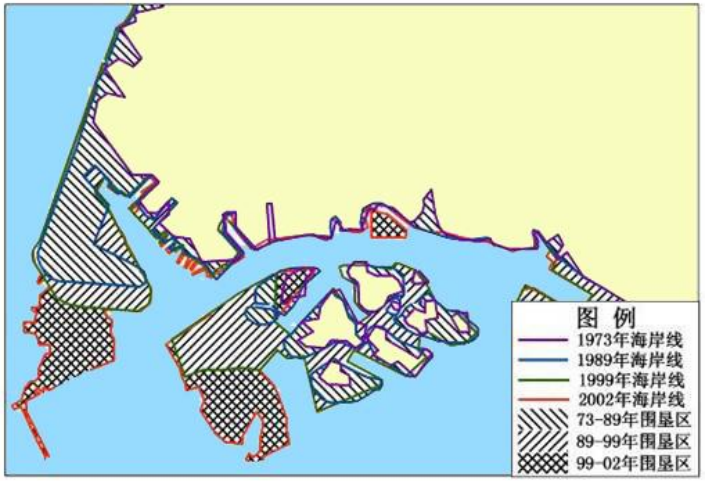
Coastline Change (1973-1989)



Coastline Change (1989-1999)



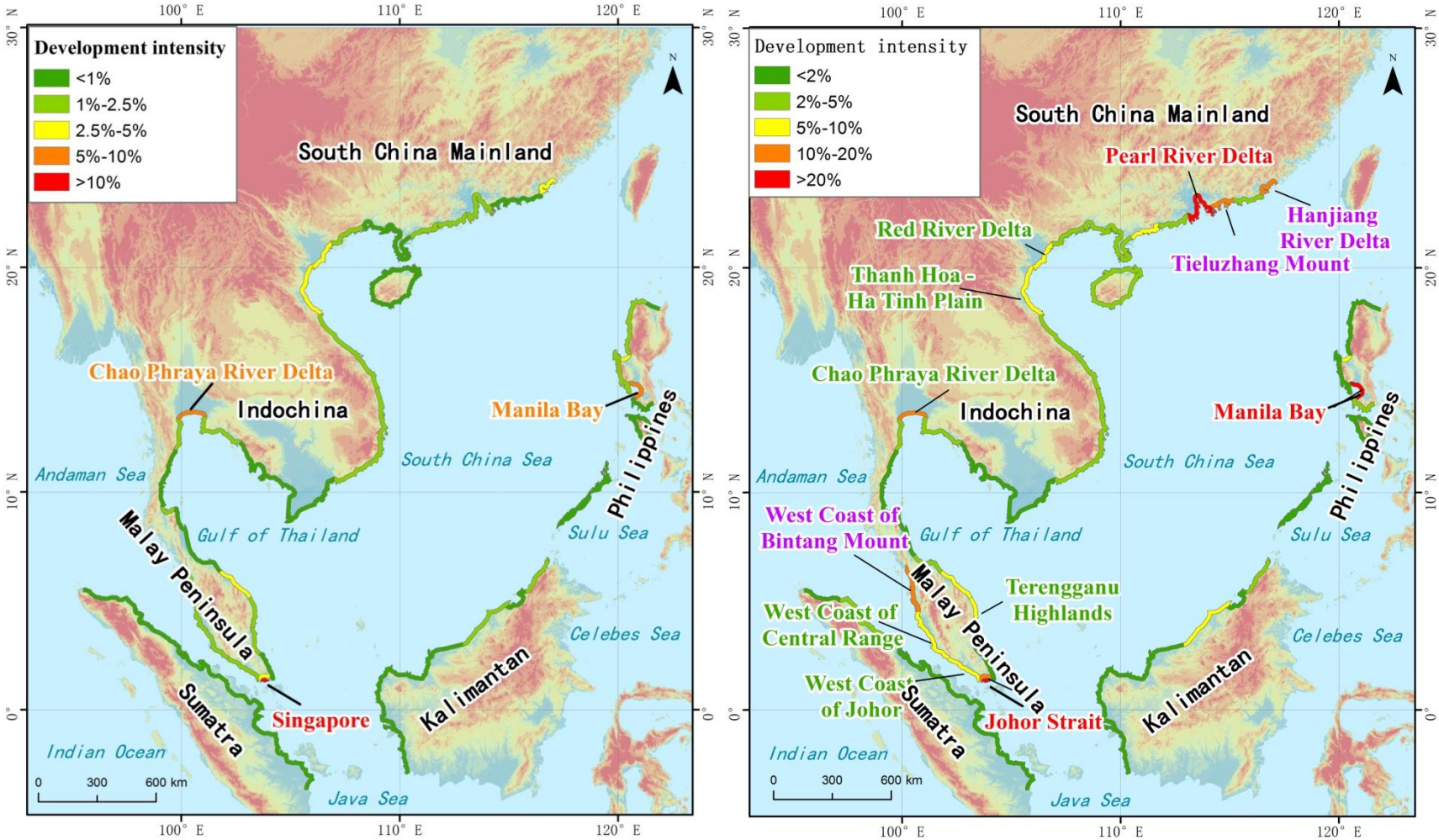
Coastline Change (1999-2002)



Coastline Change (1973-2002)

Coastline monitoring in the southwest of Singapore.

Spatial differentiation



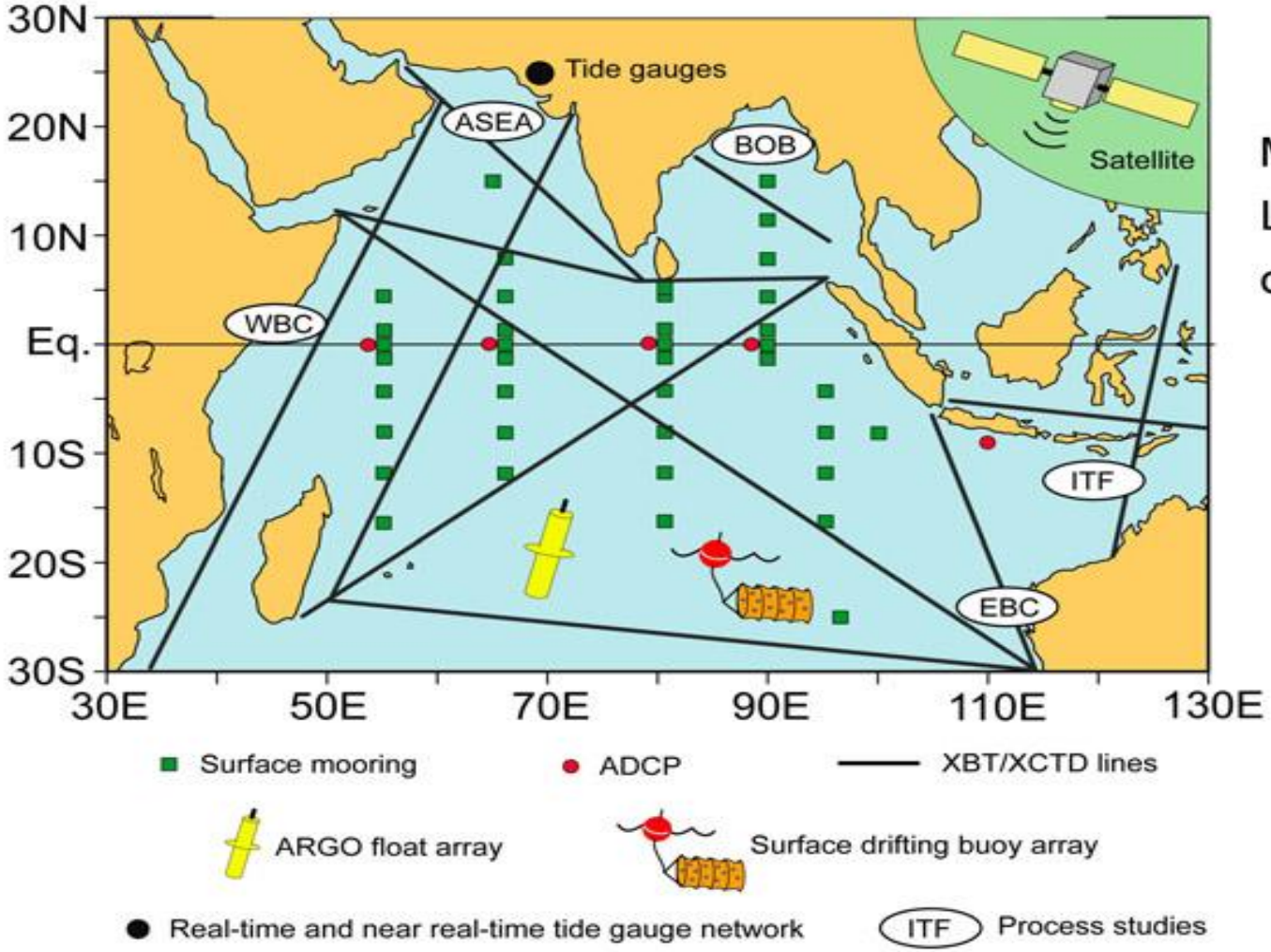
1975 2010

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

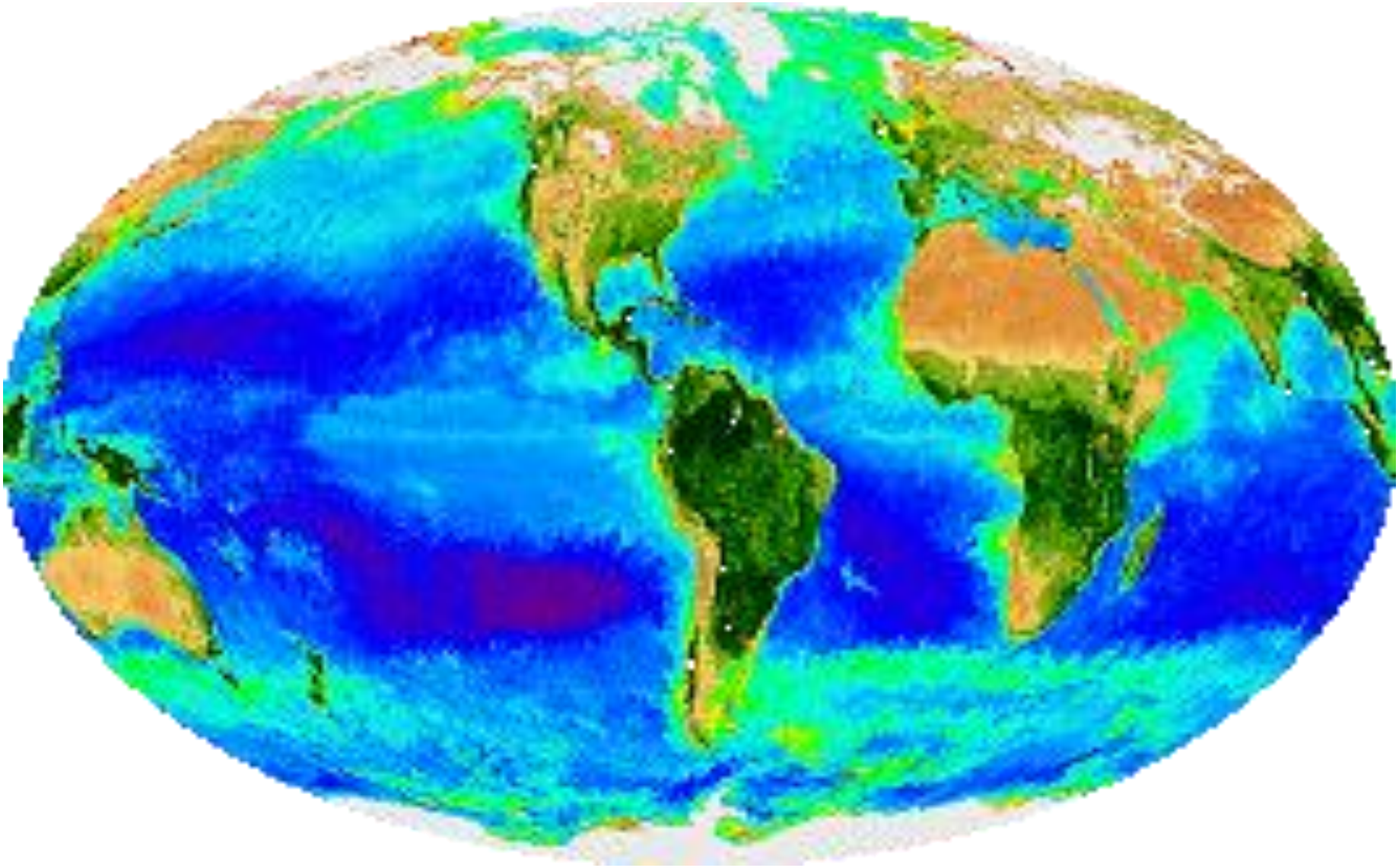
土耳其
陆上“丝绸之路”
西安
埃及
霍尔木兹海峡
泉州
巴基斯坦
合浦
广州
孟加拉
阿曼
印度
泰国
索马里
斯里兰卡
肯尼亚
印度尼西亚
印
度
洋

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
肯尼亚蒙巴萨港
马尔代夫
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

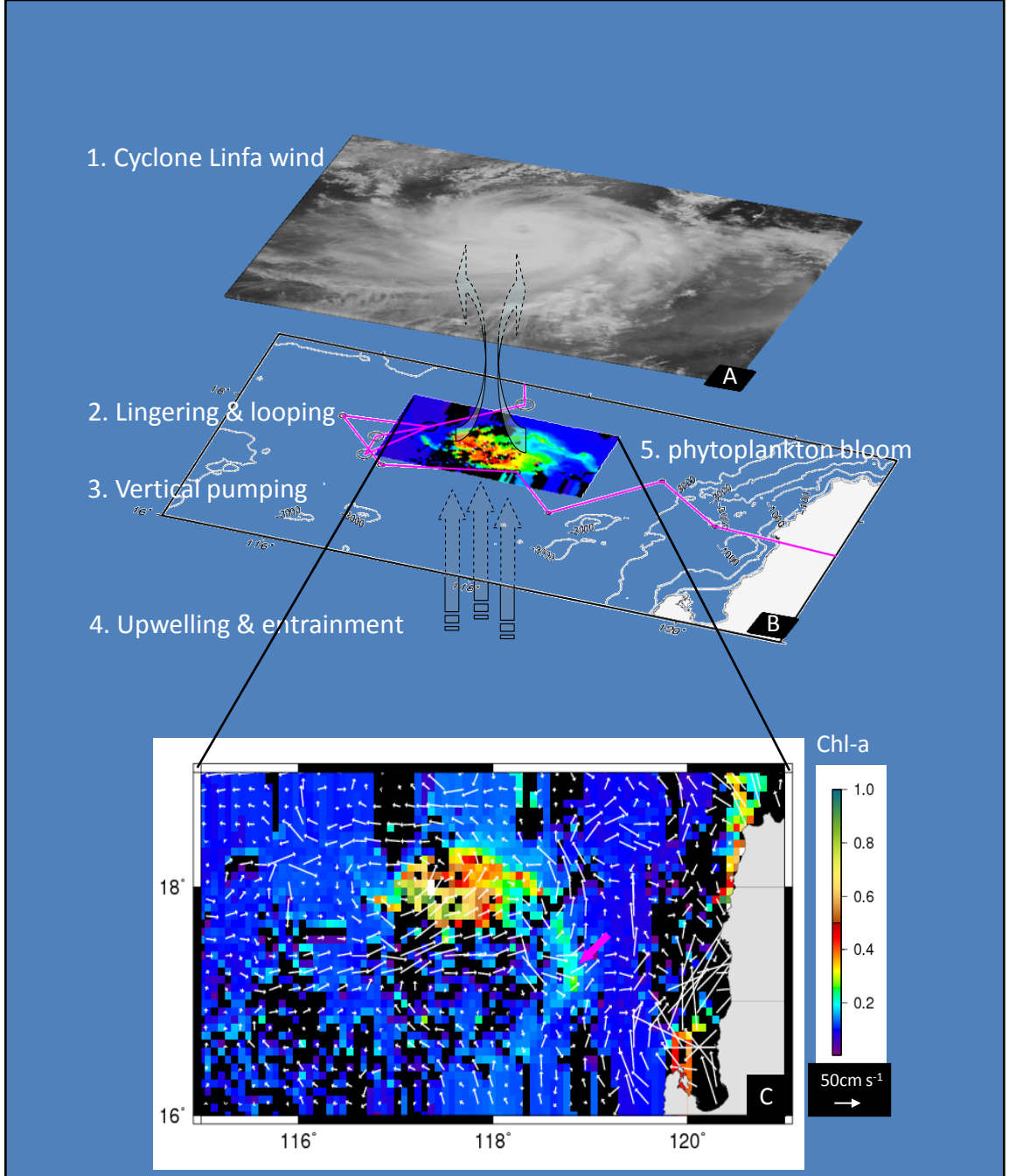
Remote Sensing of Maritime Silk Road Region -- Environments and Ecosystem

--- “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

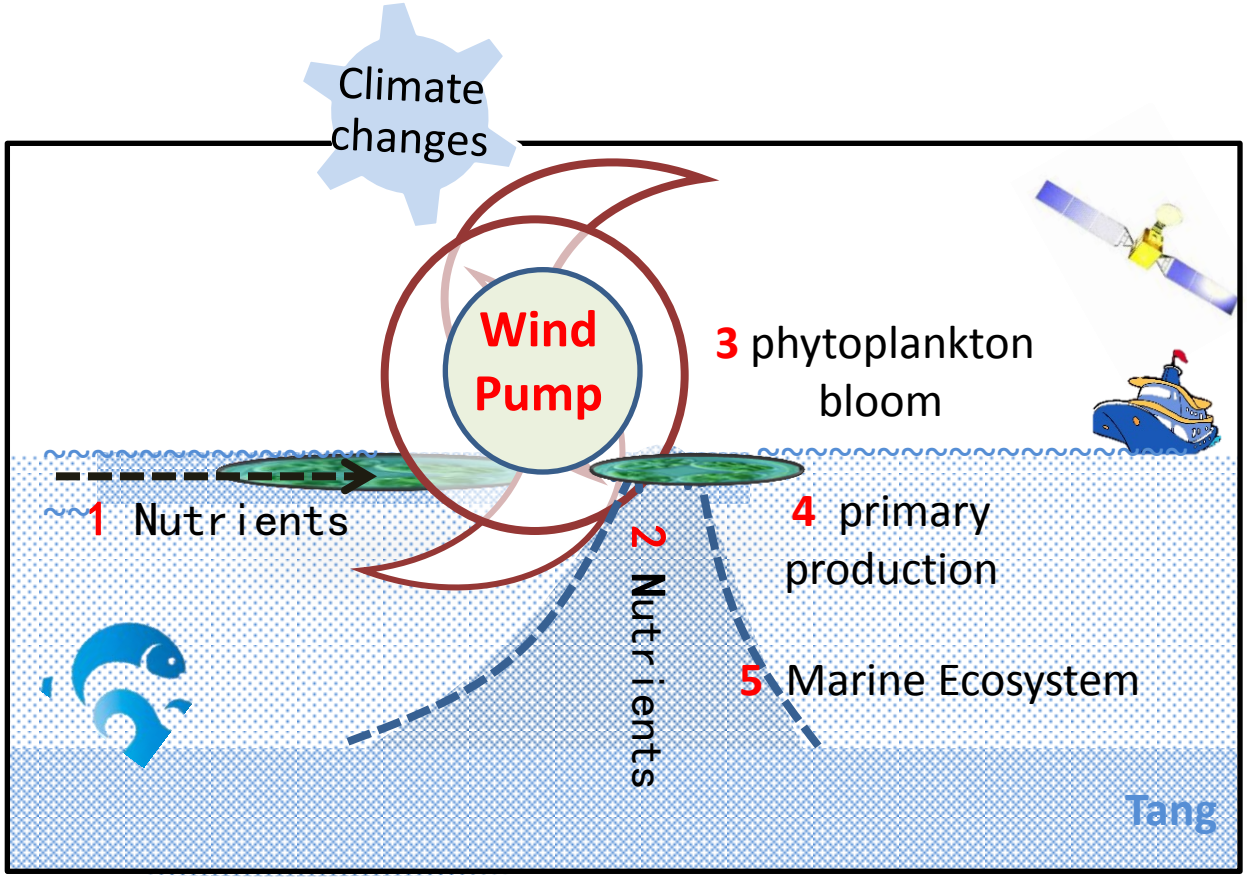


Yongqiang CHEN, DANLING TANG, 2012,

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

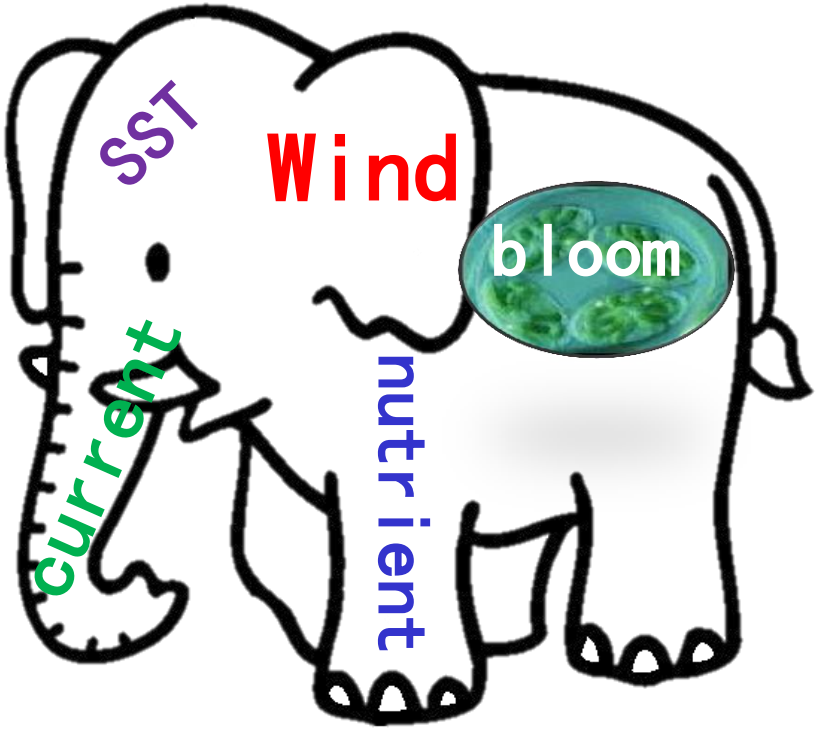
International Journal of Remote Sensing. Vol. 33, No. 23, 10 December 2012, 7444–7457.（SCI）

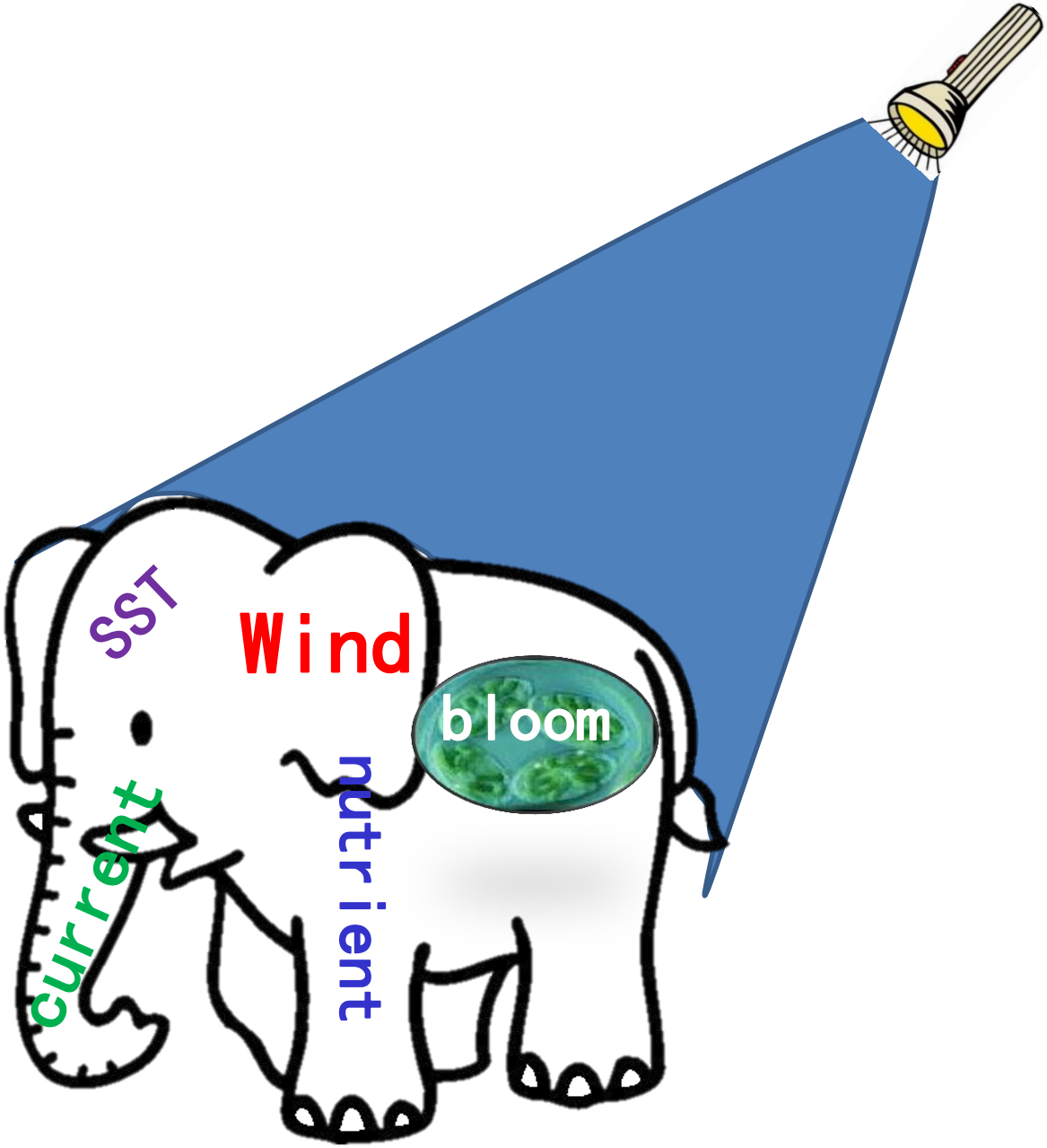
Chen, Tang , 2011, IJRS



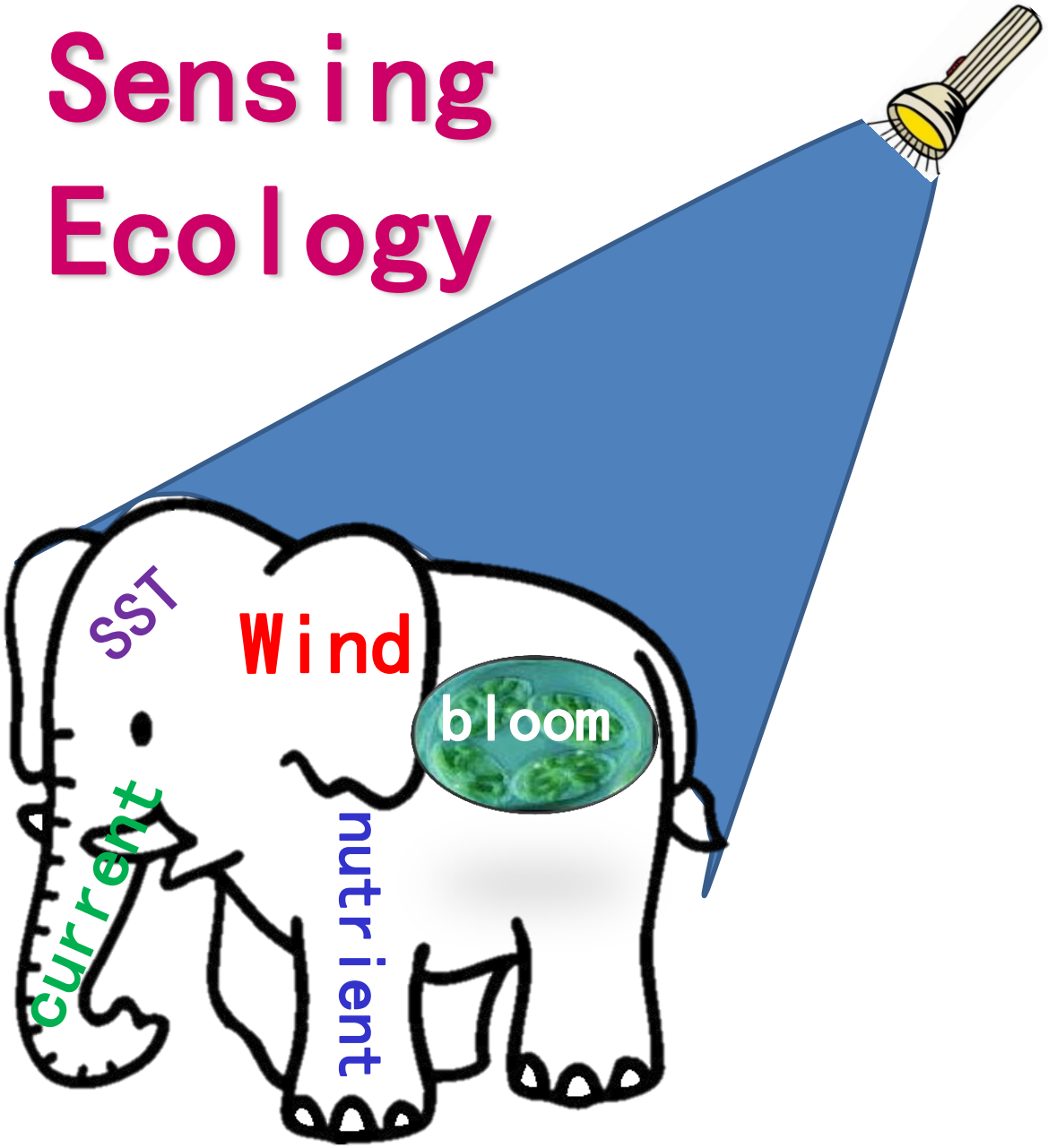
Climate – "Wind Pump" –

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


SST
Wind
bloom
current
nutrient


SST
Wind
bloom
current
nutrient

Remote Sensing Marine Ecology



International Think Tank Forum

Marine Environmental Protection: Prospects and Challenges?

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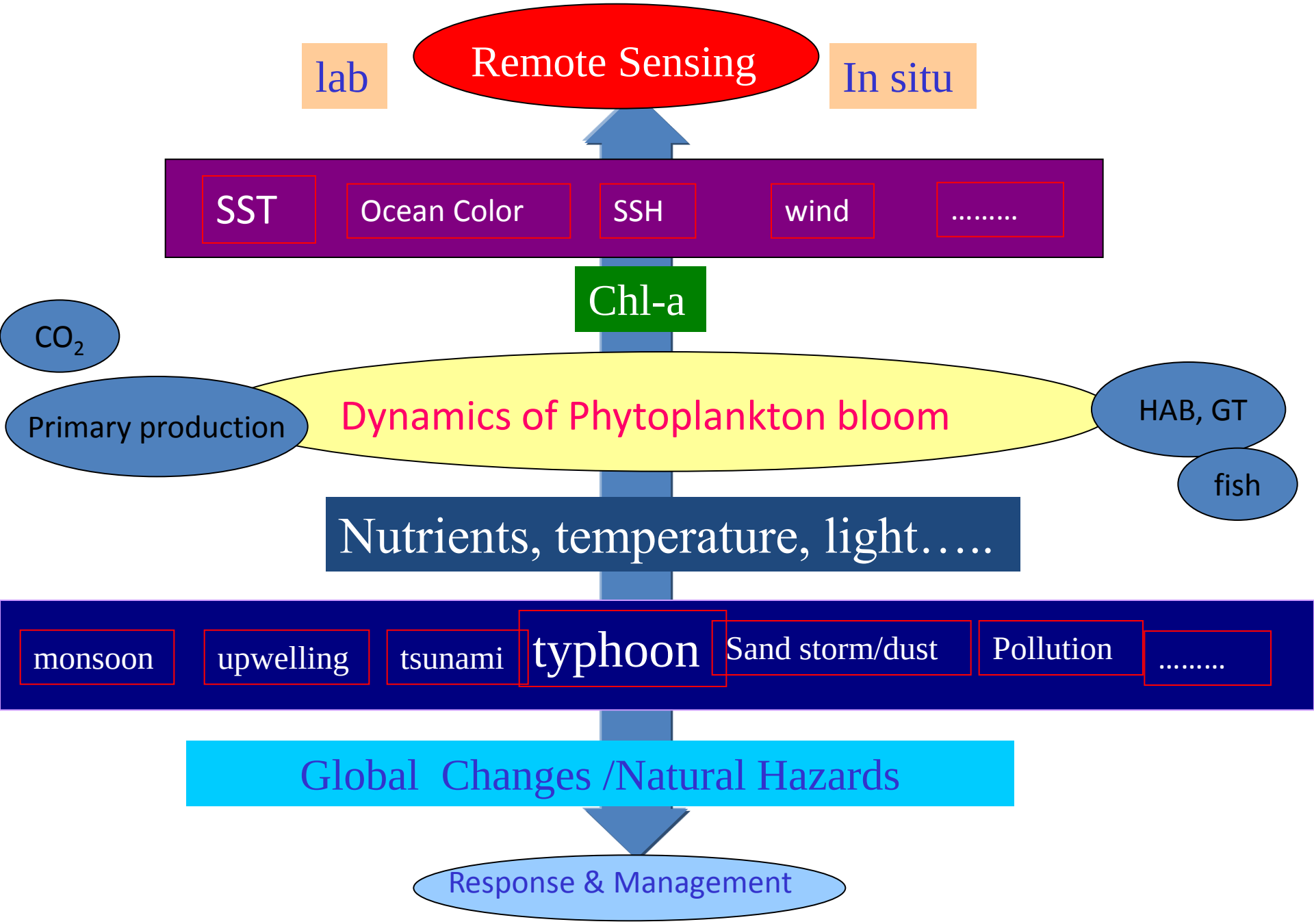
中国科学院　南海海洋研究所

South China Sea Institute of Oceanology

Chinese Academy of Sciences


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