Typhoon Wind-pimp Effects on Marine Ecosystem in the South China Sea

(Project 31451, Subproject "Upwelling")

Prof. DanLing Tang

Werner Alpers2, Haijun Ye1,
Liang Wenzhao, SONG Yongjun

South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, China
[2]Institute of Oceanography, University of Hamburg, Germany

3

1. **Typhoon wind-pump effects on air-sea CO2 flux**
2. **Upwelling effecting Distribution characteristics of phytoplankton size structure in the western SCS in summer**
3. **Mixed layer depth responses to tropical cyclones in the northeastern SCS**

Scientific question

Driver?

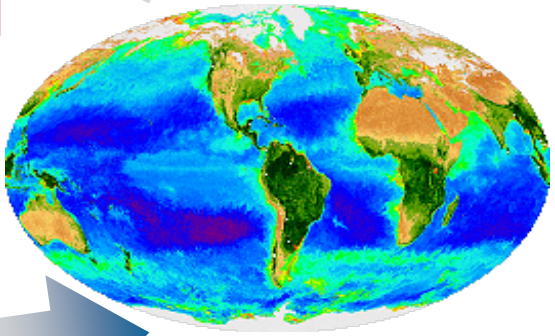
Ocean dynamic ?

Climate change→Marine Ecosystem→Phytoplankton?

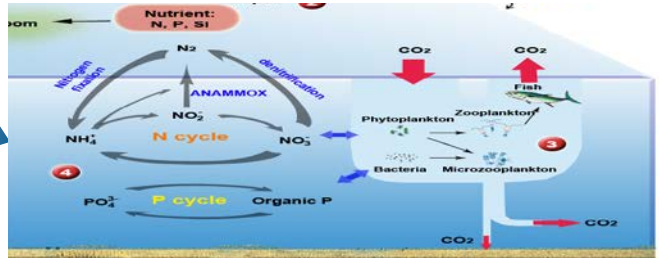
Climate Changes

Co2

wind



Marine system

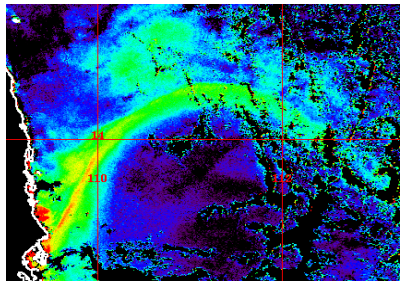


Phytoplankton

Phytoplankton

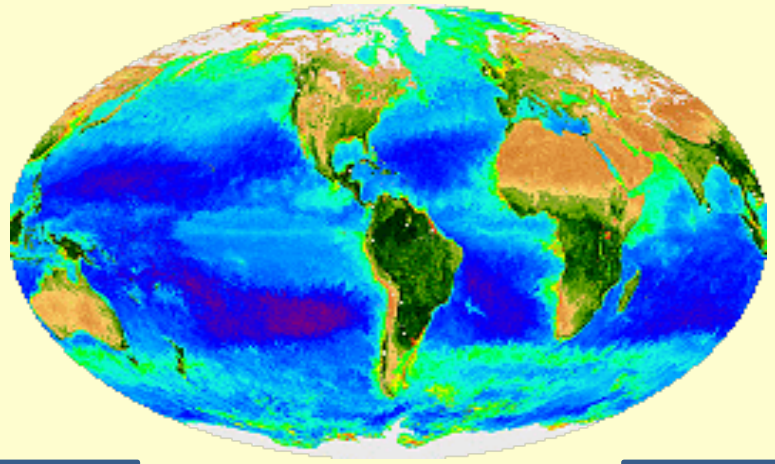
提供

Primary Production



生物资源

Bloom



参与能量传递
生源要素循环

形成

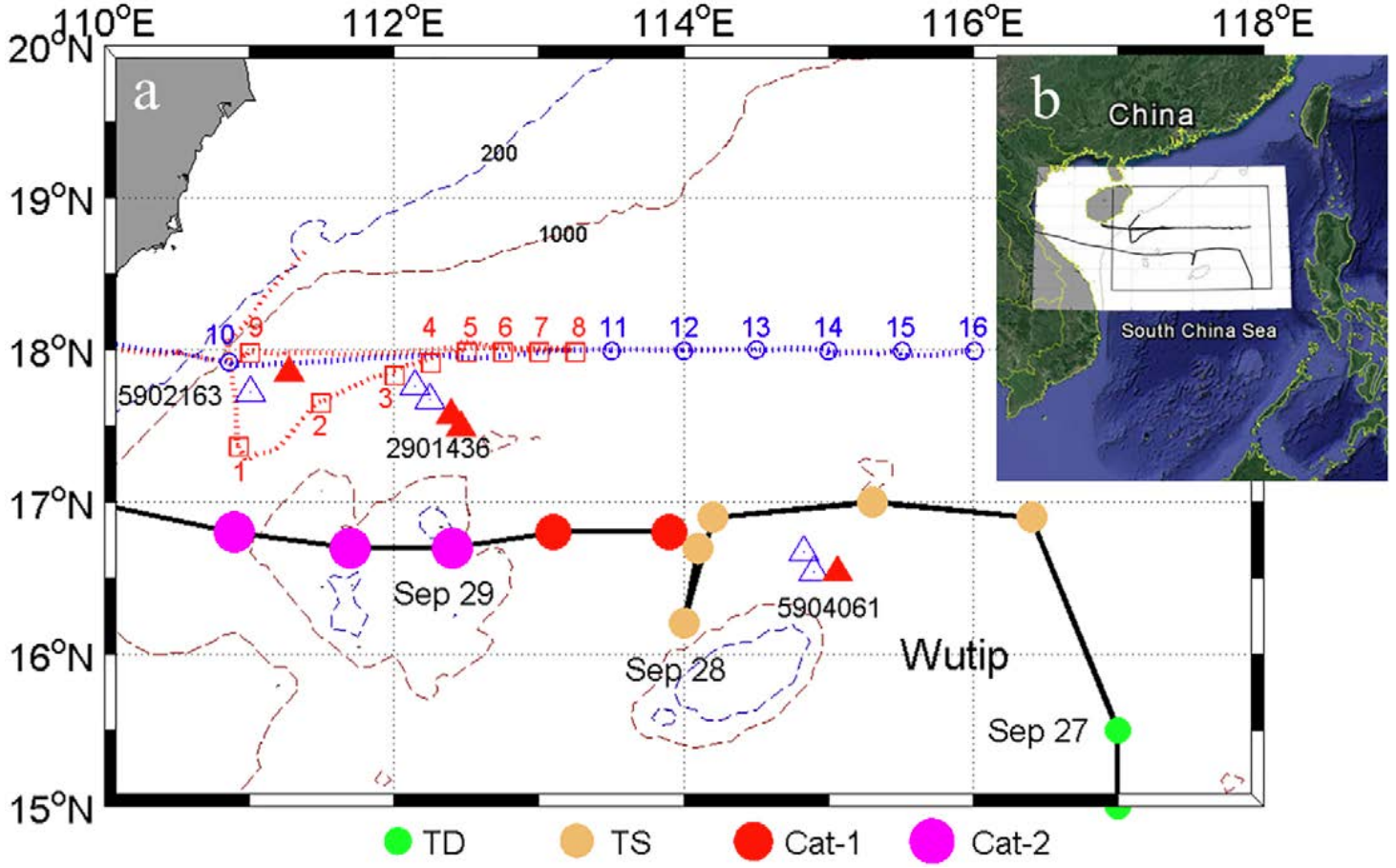
HAB

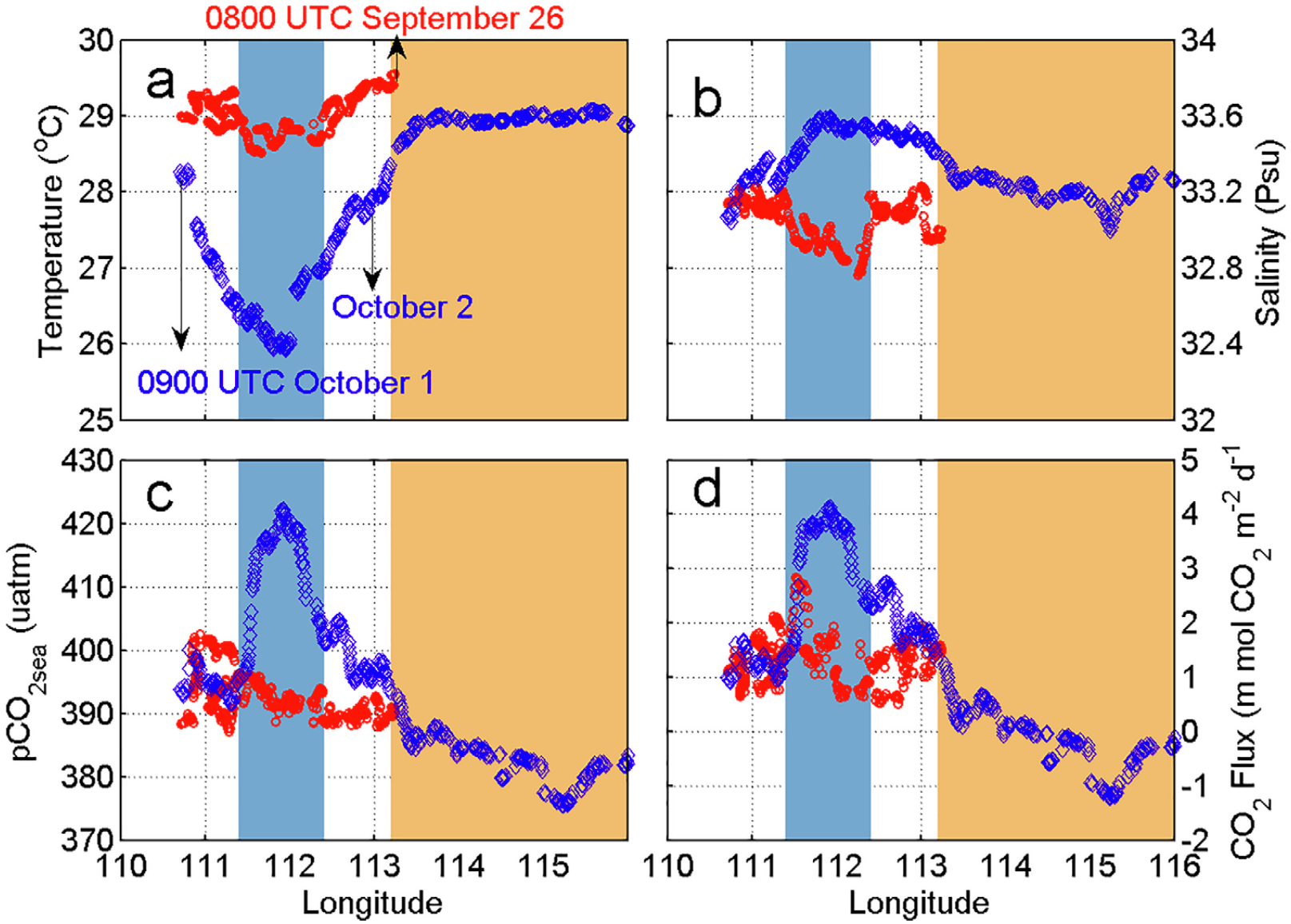
海洋灾害

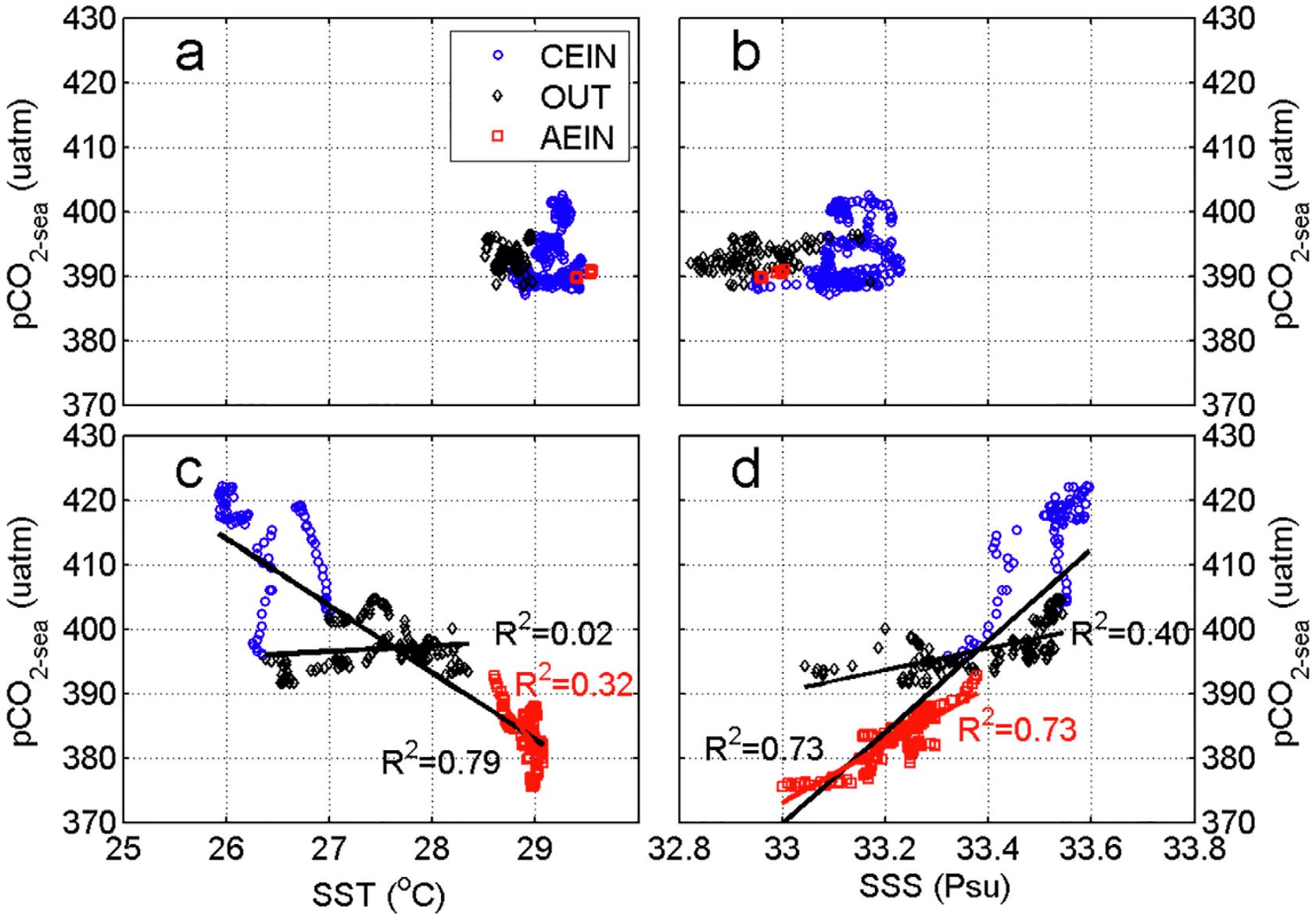
3

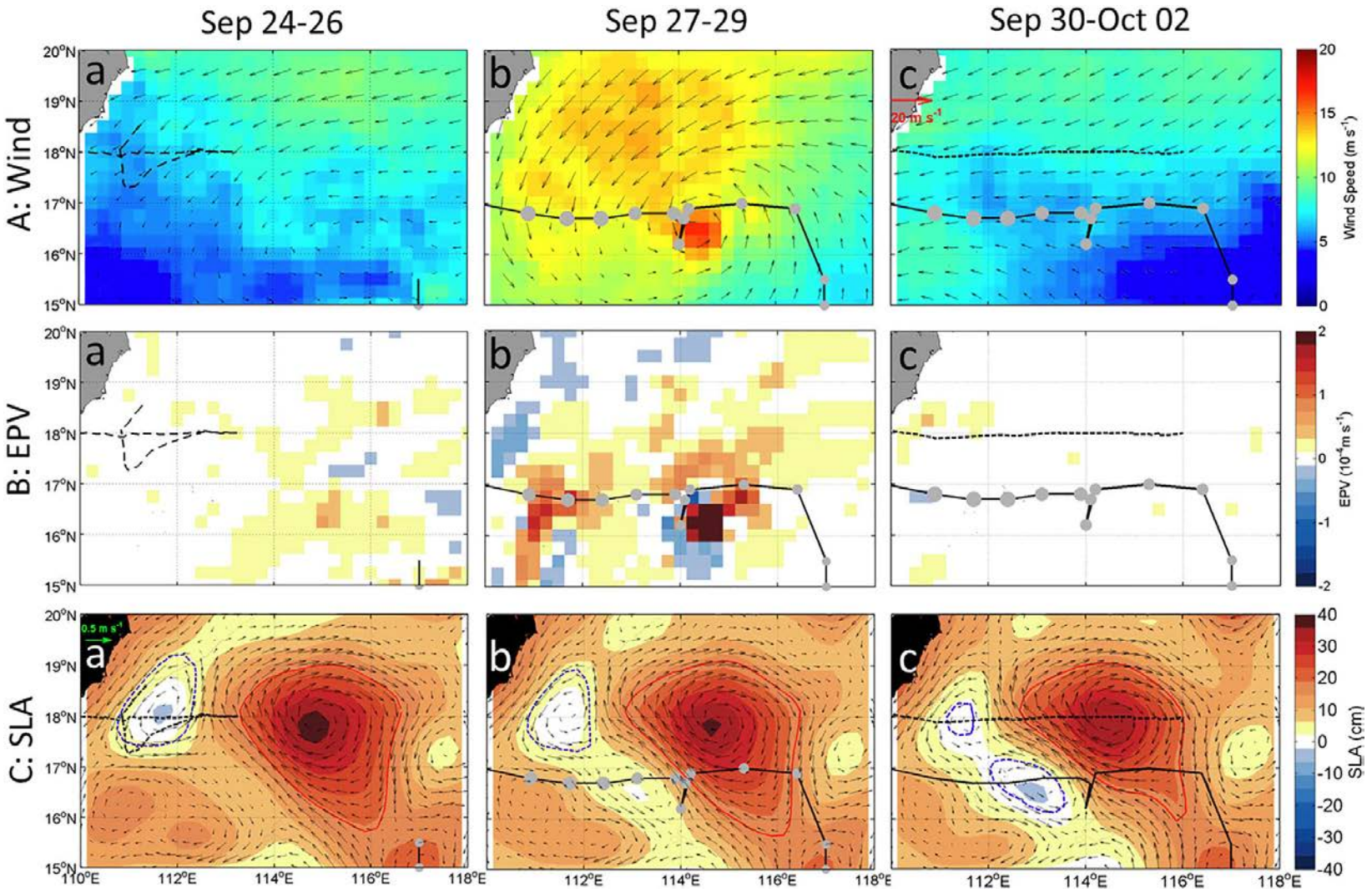
1. **Typhoon wind-pump effects on air-sea CO2 flux**
2. **Upwelling effecting Distribution characteristics of phytoplankton size structure in the western SCS in summer**
3. **Mixed layer depth responses to tropical cyclones in the northeastern SCS**

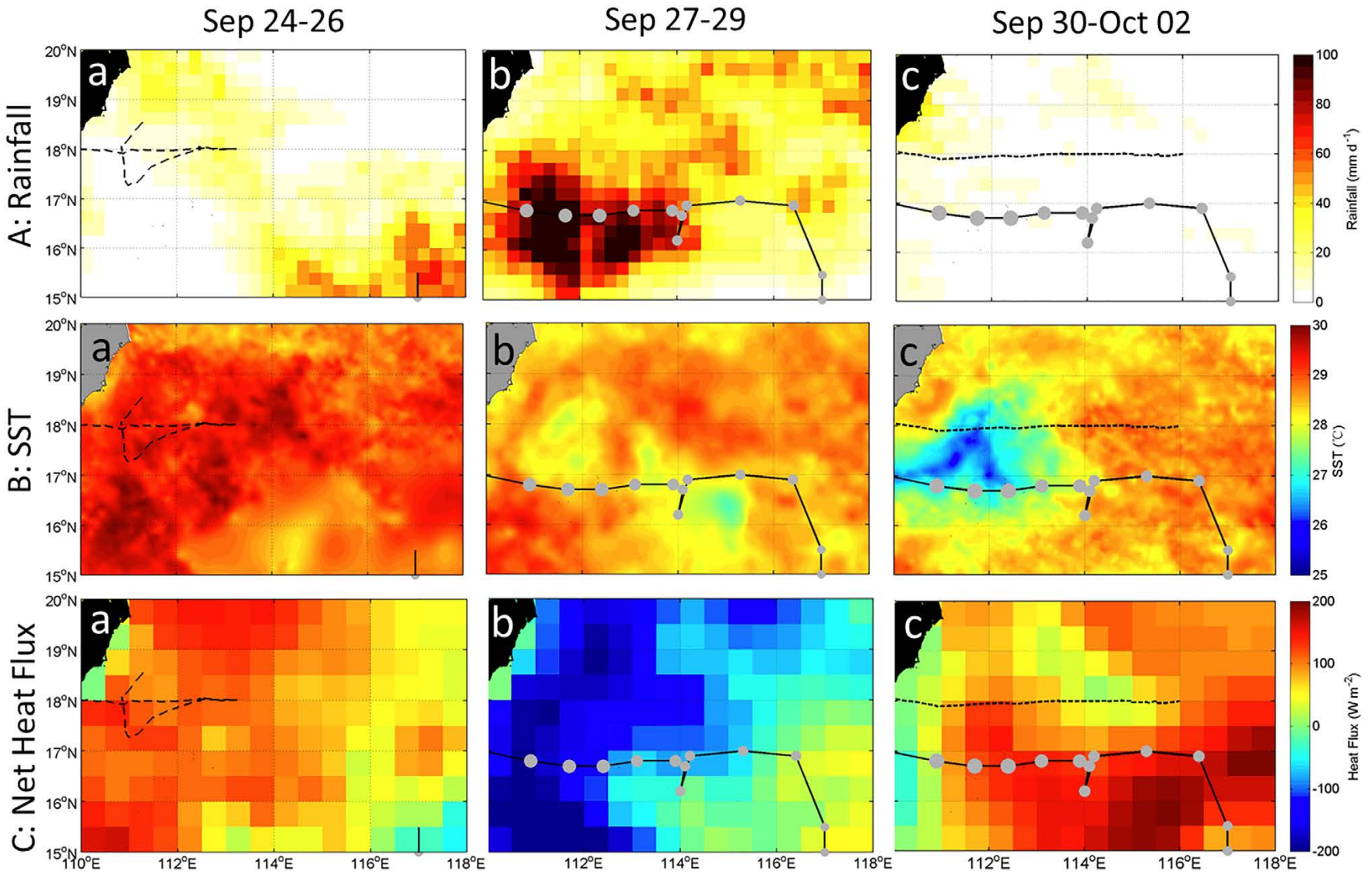
- Storm-induced changes in pCO2 at the sea surface over the northern South China Sea during Typhoon Wutip

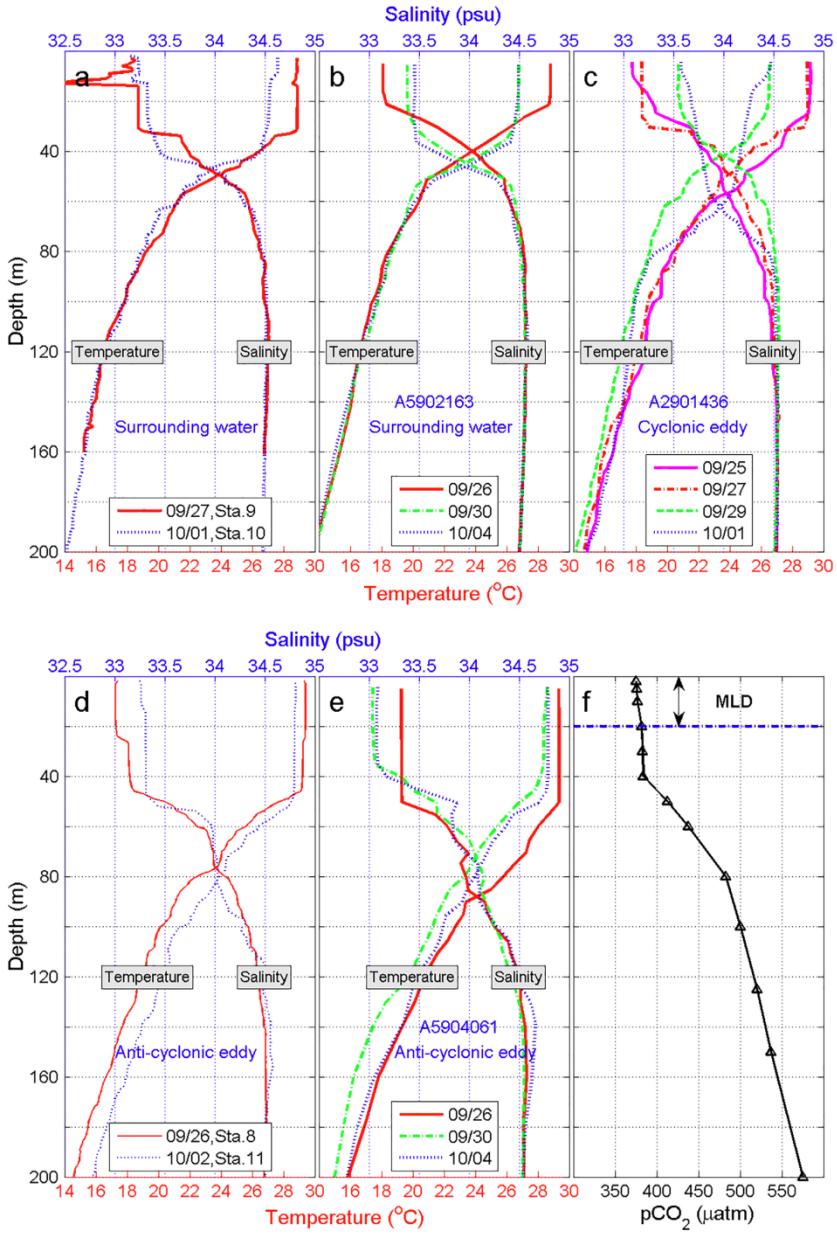


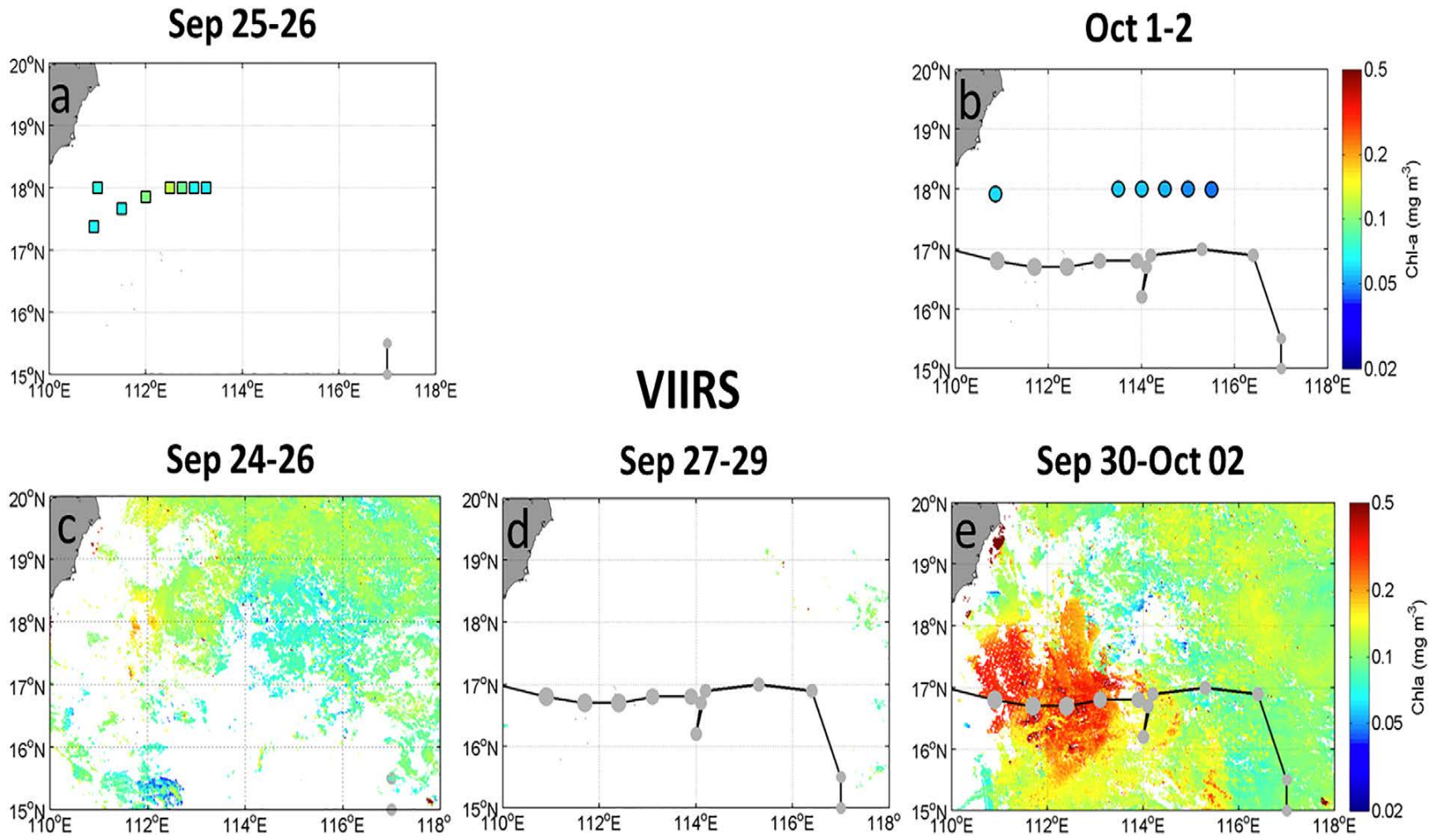

0800 UTC September 26
a
b
c
d
Temperature (°C)
Salinity (Psu)
pCO2sea (uatm)
CO2 Flux (m mol CO2 m-2 d-1
October 2
0900 UTC October 1
Longitude
Longitude
30
29
28
27
26
25
34
33.6
33.2
32.8
32.4
32
430
420
410
400
390
380
370
5
4
3
2
1
0
-1
-2
110
111
112
113
114
115
116


a
b
c
d
CEIN
OUT
AEIN
pCO2-sea (uatm)
SST (°C)
SSS (Psu)
R2=0.02
R2=0.32
R2=0.79
R2=0.40
R2=0.73
R2=0.73


Sep 24-26
Sep 27-29
Sep 30-Oct 02
A: Wind
B: EPV
C: SLA
a
b
c
20°N
19°N
18°N
17°N
16°N
15°N
110°E
112°E
114°E
116°E
118°E
20 m s-1
0.5 m s-1
Wind Speed (m s-1)
EPV (10-4m s-1)
SLA (cm)


Sep 24-26
Sep 27-29
Sep 30-Oct 02
A: Rainfall
B: SST
C: Net Heat Flux
a
b
c
20°N
19°N
18°N
17°N
16°N
15°N
110°E
112°E
114°E
116°E
118°E
Rainfall (mm d-1)
SST (°C)
Heat Flux (W m-2)


Salinity (psu)
32.5 33 33.5 34 34.5 35
33 33.5 34 34.5 35
33 33.5 34 34.5 35
a
b
c
Depth (m)
40
80
120
160
200
Temperature
Salinity
Surrounding water
09/27,Sta.9
10/01,Sta.10
A5902163
Surrounding water
09/26
09/30
10/04
A2901436
Cyclonic eddy
09/25
09/27
09/29
10/01
14 16 18 20 22 24 26 28 30
Temperature (°C)
Salinity (psu)
d
e
f
MLD
Anti-cyclonic eddy
09/26,Sta.8
10/02,Sta.11
A5904061
Anti-cyclonic eddy
350 400 450 500 550
pCO2 (µatm)


Sep 25-26
Oct 1-2
VIIRS
Sep 24-26
Sep 27-29
Sep 30-Oct 02
a
b
c
d
e
20°N
19°N
18°N
17°N
16°N
15°N
110°E
112°E
114°E
116°E
118°E
0.5
0.2
0.1
0.05
0.02
Chl-a (mg m-3)
Chla (mg m-3)

3

1. Typhoon wind-pump effects on air-sea CO2 flux
2. **Upwelling effecting Distribution characteristics of phytoplankton size structure in the western SCS in summer**
3. Mixed layer depth responses to tropical cyclones in the northeastern SCS

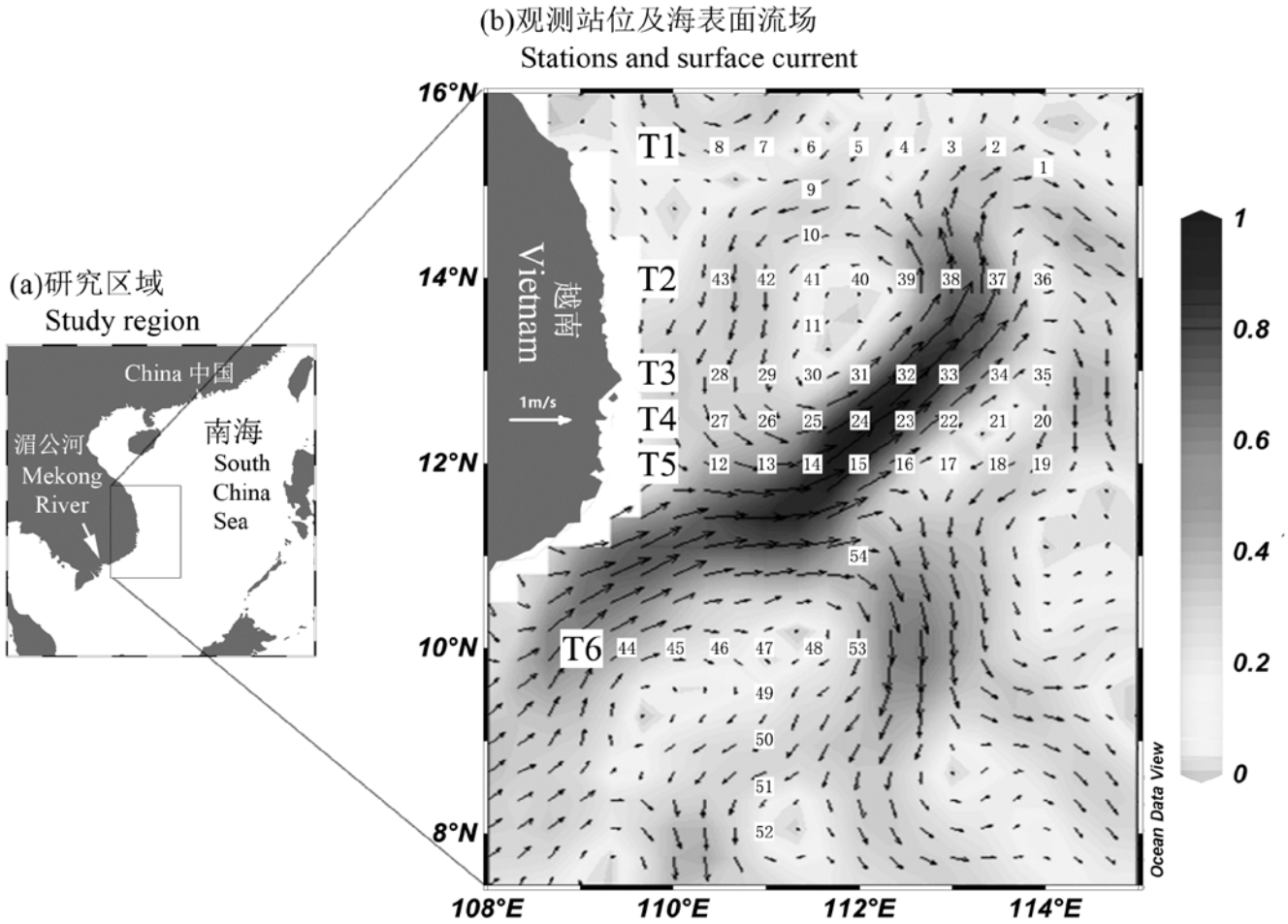


图1 （a）研究区域的地理位置；（b）观测站点、断面及海表流场图

Fig. 1 (a) The geographic location of the study region in the west South China Sea; (b)Location of sampling stations and transects merged with Sea surface current in study period.

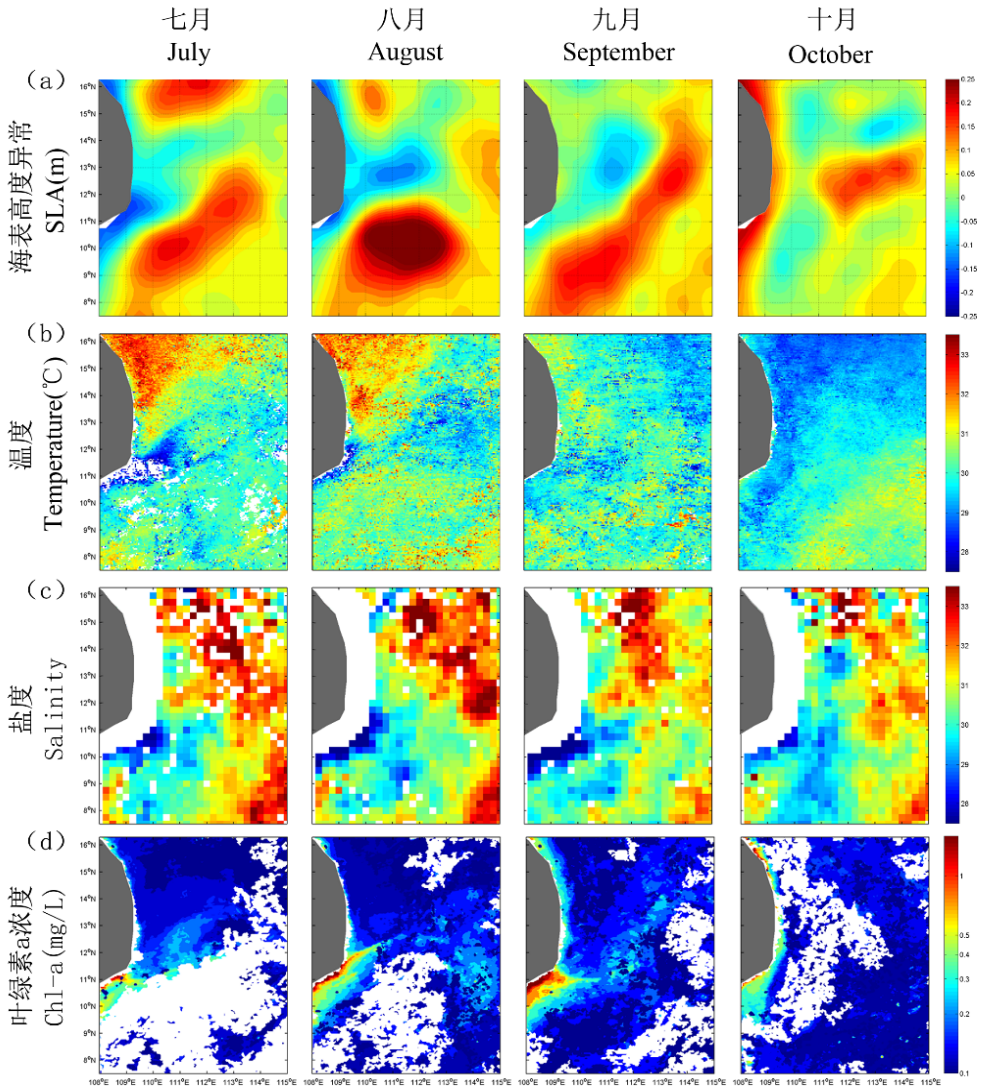


图2 2014年7月至10月南海西部海洋表面（a）海表高度异常；（b）温度；（c）盐度；（d）叶绿素*a*浓度分布图

Fig.2 (a) Sea level anomaly, (b) Temperature, (c) Salinity, (d) Chlorophyll *a* concentration of the surface water in western South China Sea from July to October in 2014.

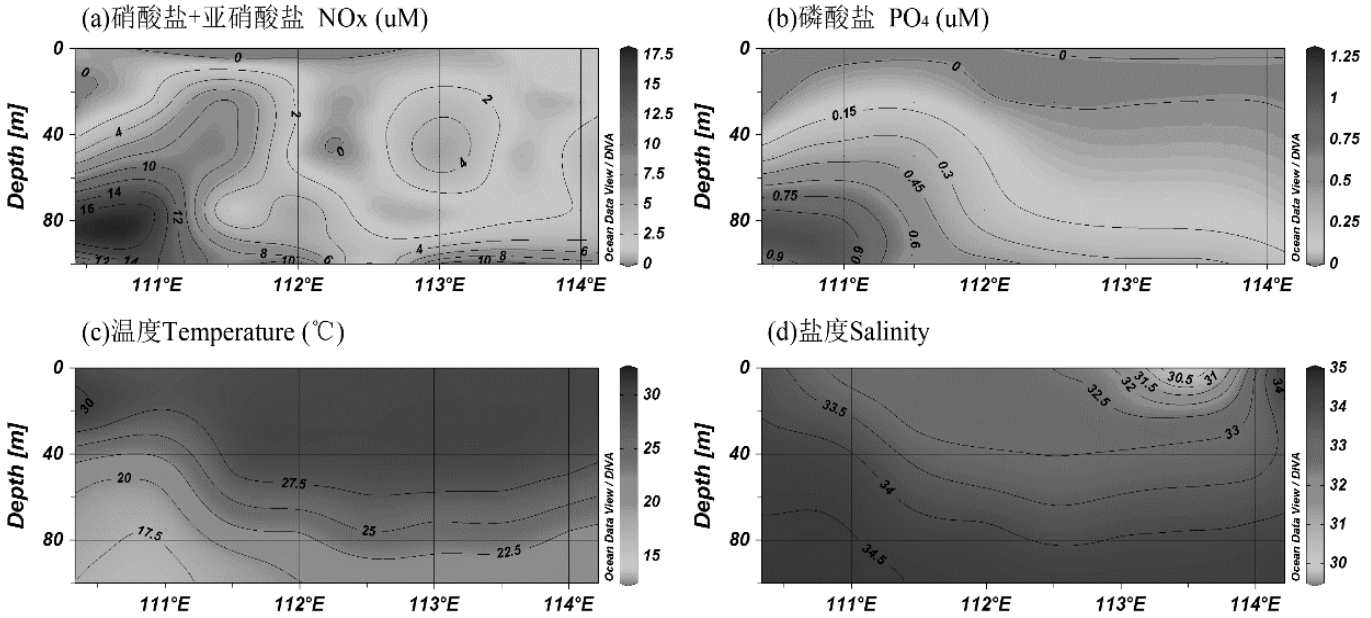


图3 断面T5（12 ° N）的垂直剖面（a）硝酸盐+亚硝酸盐、（b）磷酸盐、（c）温度、（d）盐度分布图

Fig. 3 The vertical sections of (a) nitrite+nitrate, (b) phosphate, (c) temperature, (d) salinity in upper 100 m along transect T5 (12 ° N)

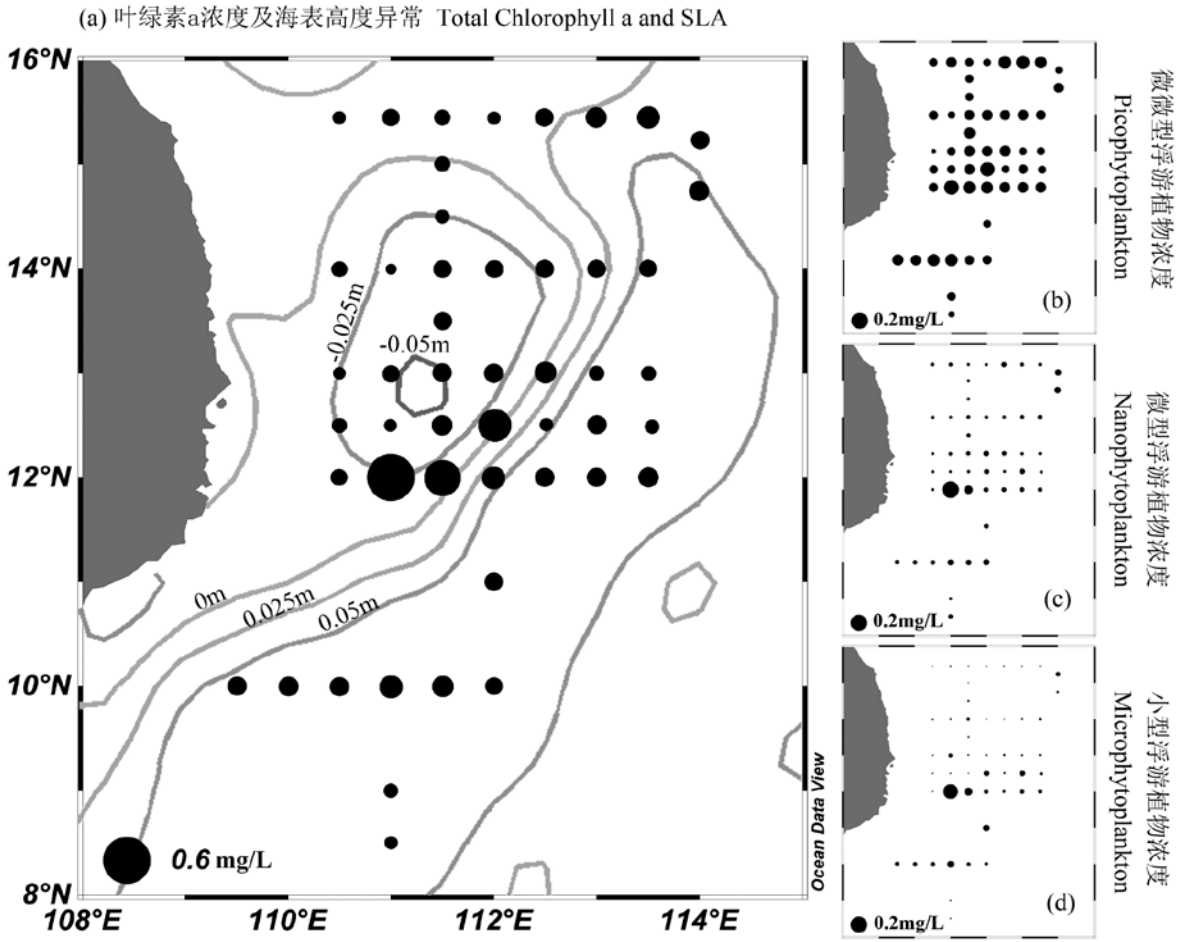


图4 现场观测期间的（a）总叶绿素浓度及2014年9月海表高度异常卫星数据; （b）微微型浮游植物浓度；（c）微型浮游植物浓度; （d）小型浮游植物浓度分布图

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.

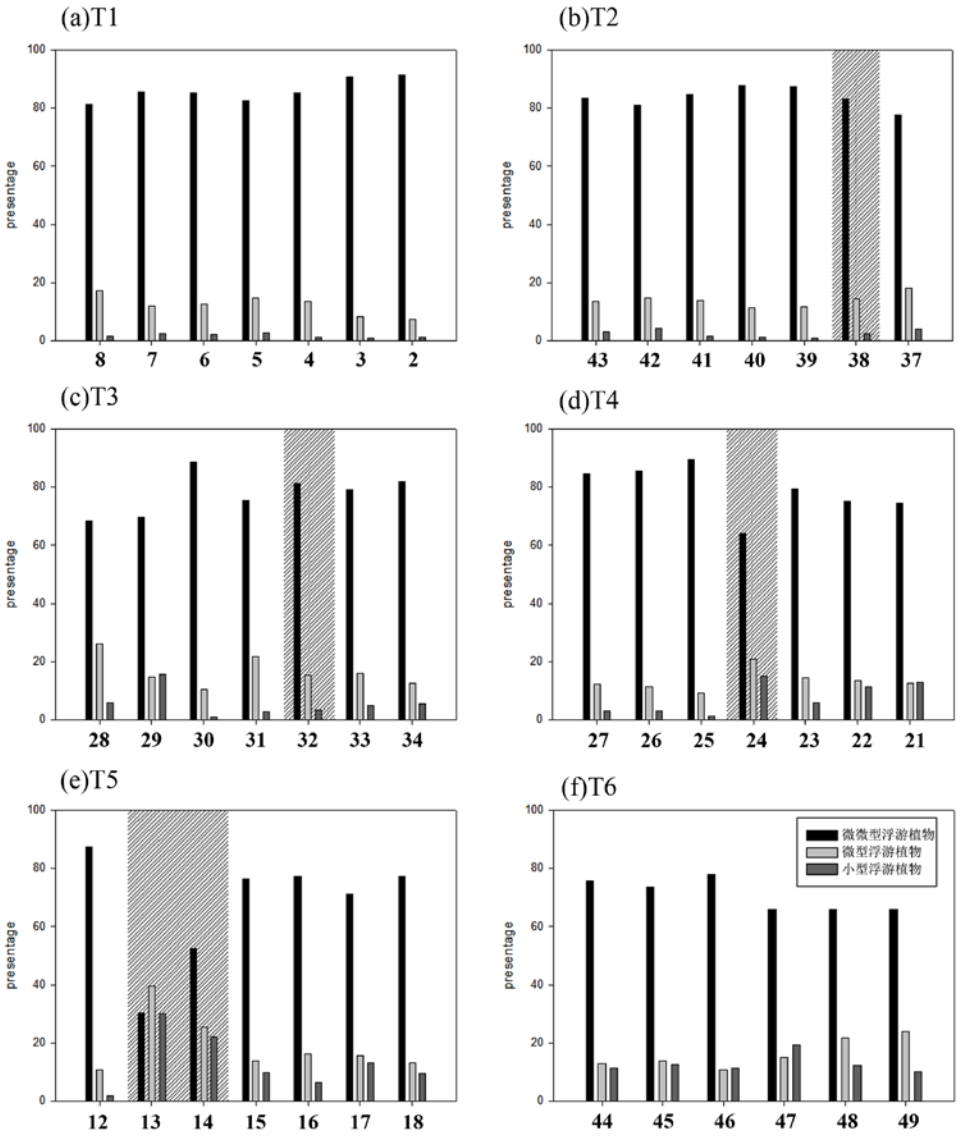


图5 断面（a）T1、（b）T2、（c）T3、（d）T4、（e）T5、（f）T6 上各站点表层不同粒径大小占总叶绿素的比例。灰色背景表示急流区域。

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.

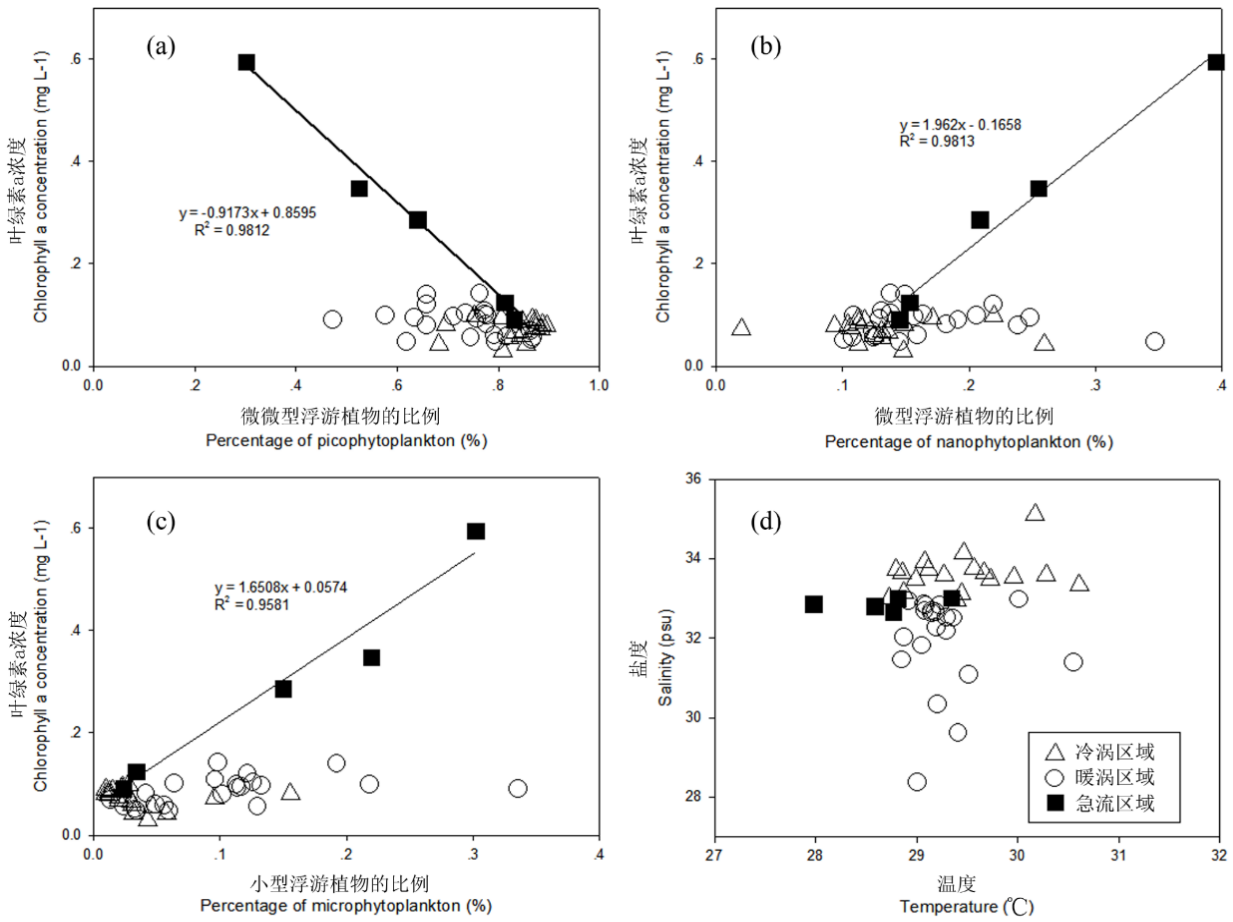


图6 叶绿素*a*浓度与（a）微微型浮游植物的比例；（b）微型浮游植物的比例；（c）小型浮游植物的比例的相关性。（d）温度与盐度的相关性。

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.

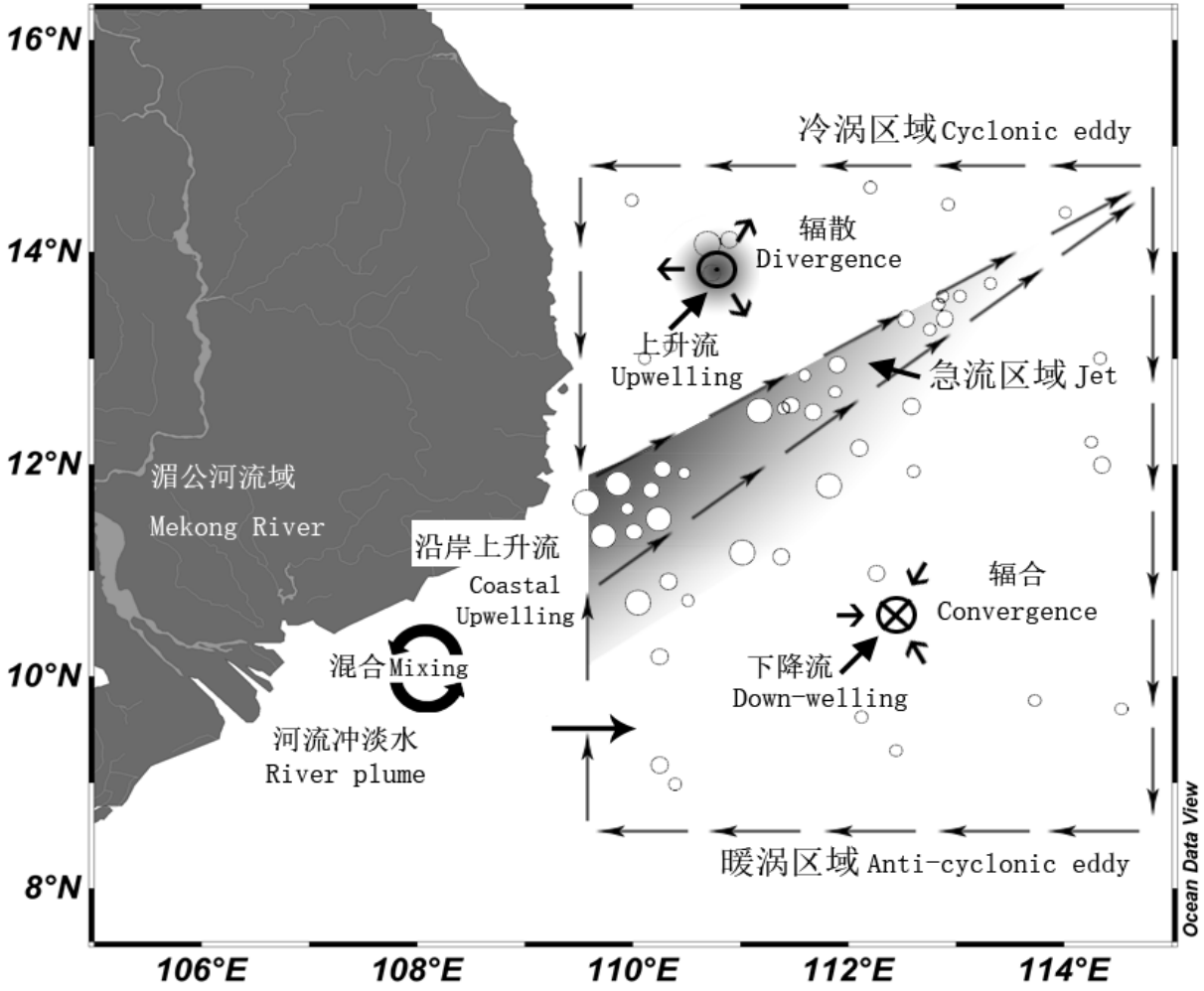


图7 南海夏季海表浮游植物粒径结构及影响机制概念图

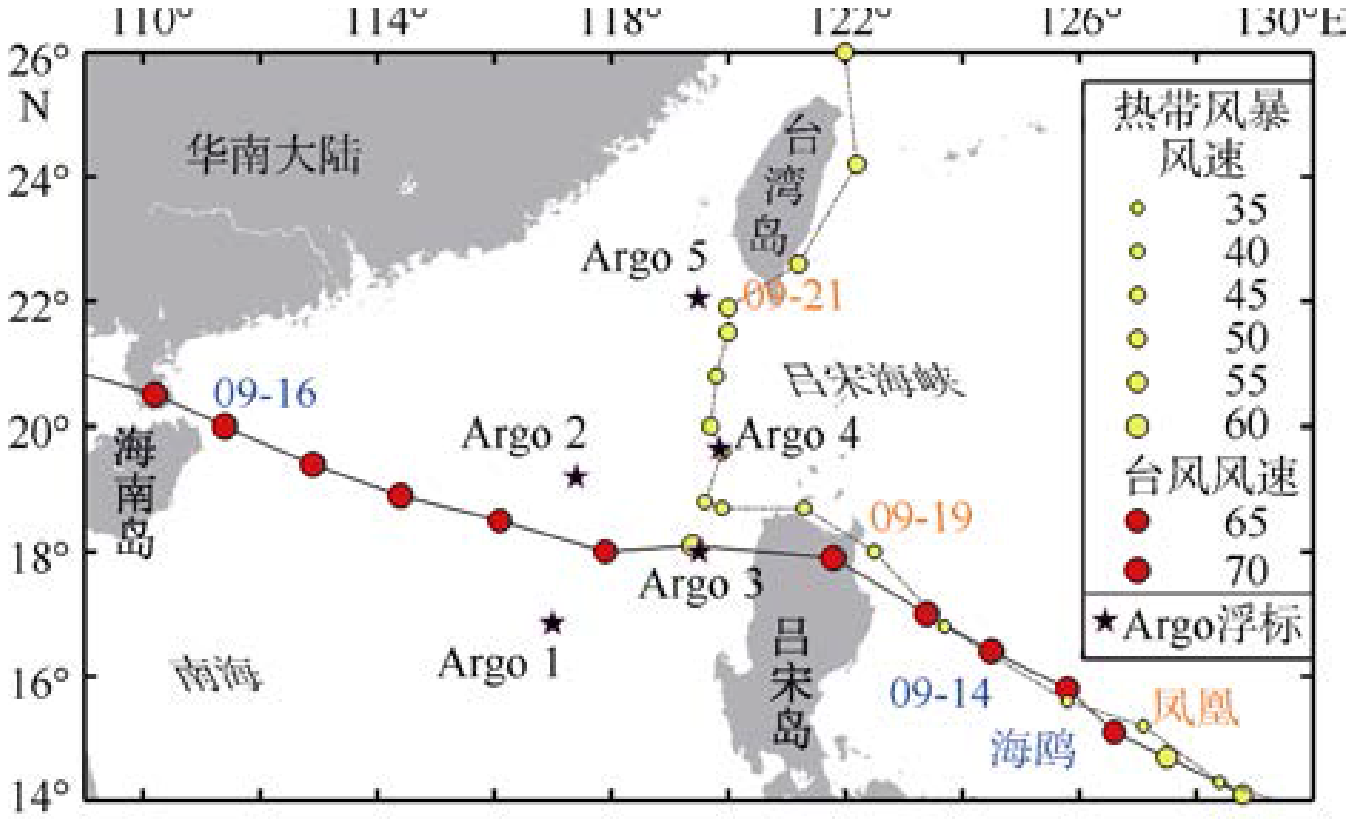
Fig.7 Conceptual sea surface size structure characteristics of phytoplankton and its influence mechanism in summertime western South China Sea.

- physical processes significantly influence summertime surface phytoplankton size structure in western South China Sea.
- Both jet and eddies can effect phytoplankton size structure by increasing the contribution of microphytoplankton. Surface horizontal advection of phytoplankton by northeastward jet form the coastal upwelling area is the main source of microphytoplankton in open sea.
- The interactions of convergence and divergence in eddies with jet form a chlorophyll front and increase the microphytoplankton component.
- Upwelling in the center cyclonic eddy bring up nutrients which raises microphytoplankton component.

3

1. Typhoon wind-pump effects on air-sea CO2 flux
2. Upwelling effecting Distribution characteristics of phytoplankton size structure in the western SCS in summer
3. **Mixed layer depth responses to tropical cyclones in the northeastern SCS**

Mixed layer depth responses to tropical cyclones Kalmaegi and Fung-Wong in the northeastern South China Sea



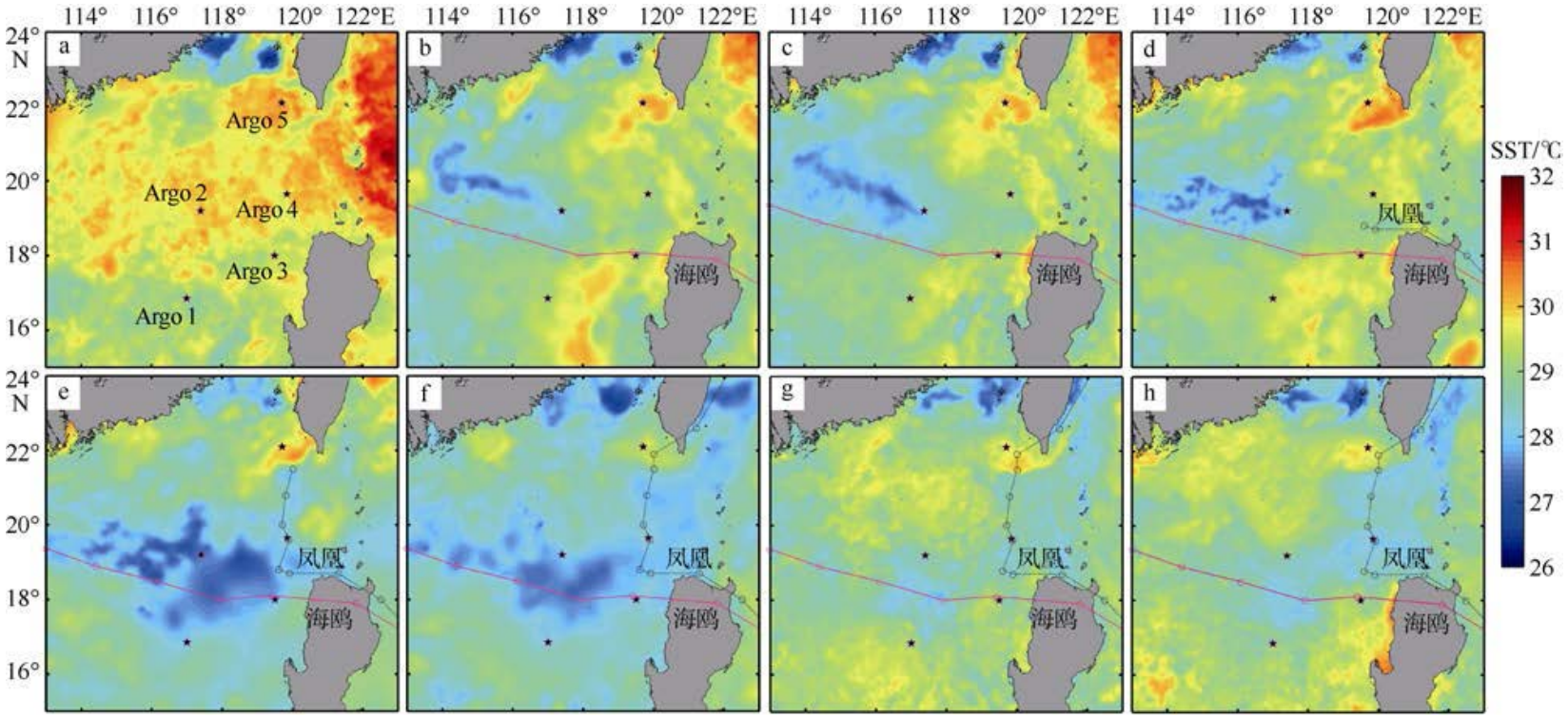
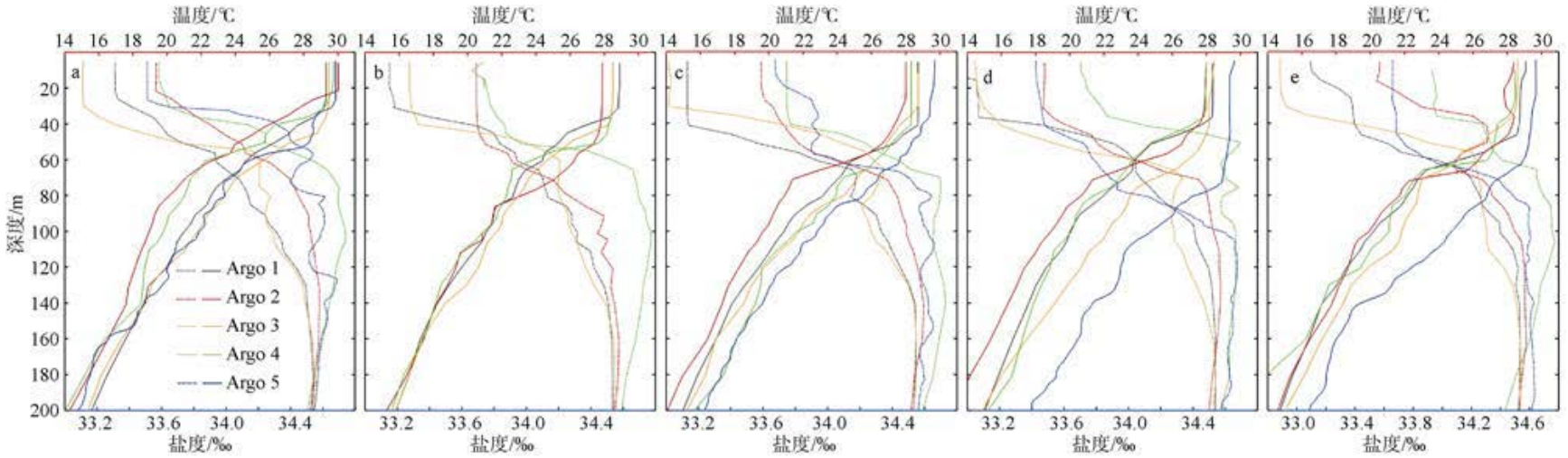
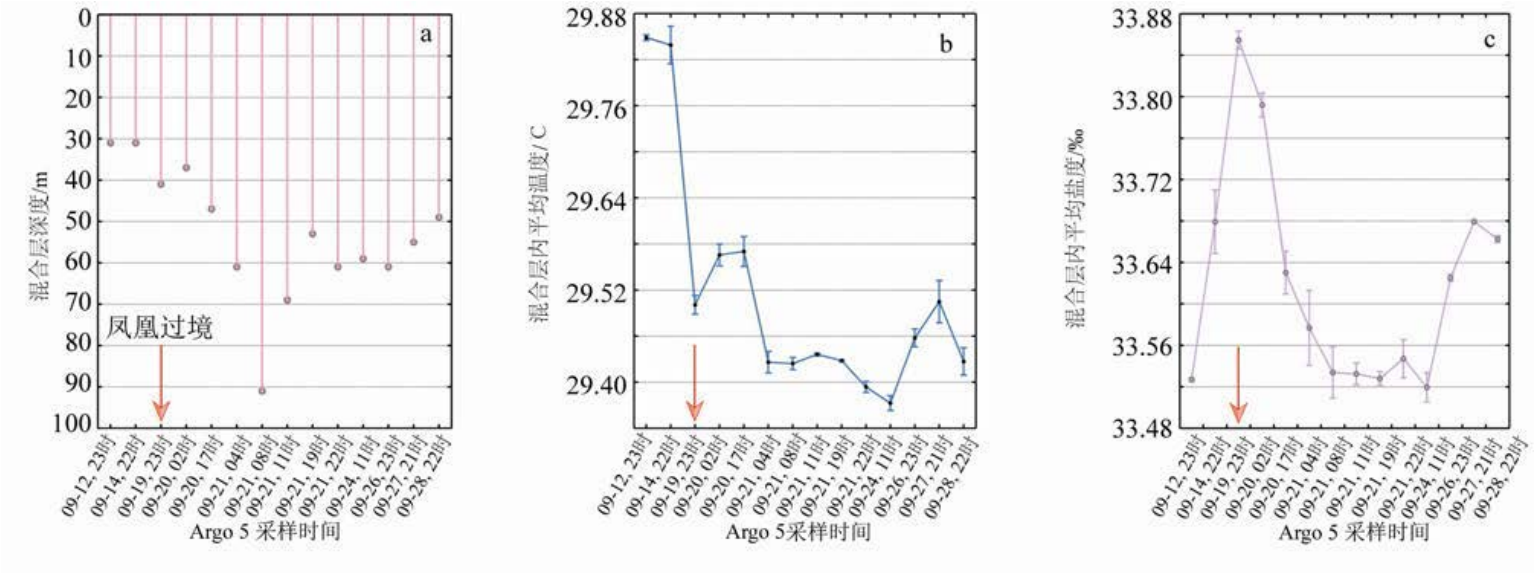


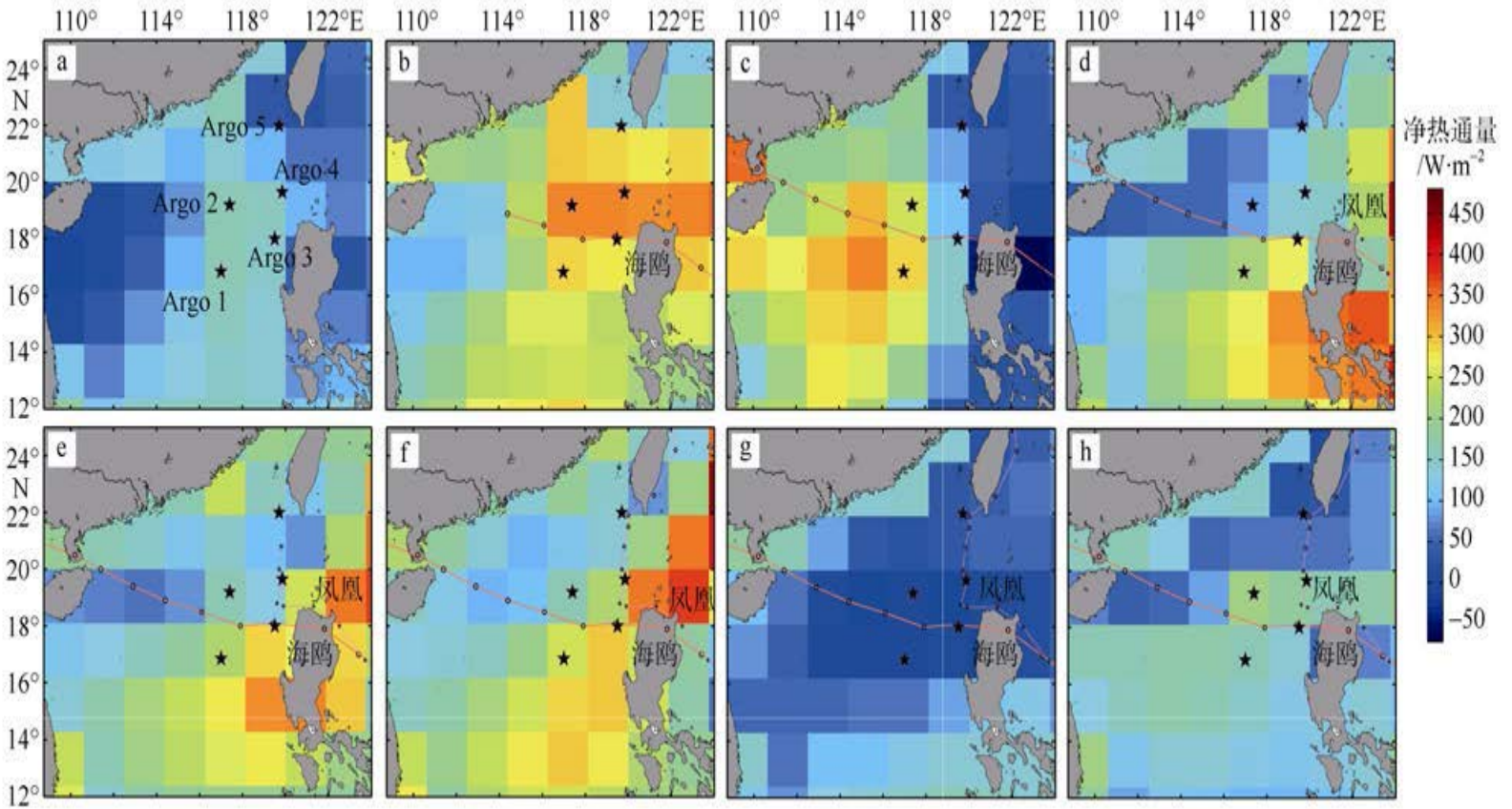
Fig. 2 Changes of SST in responses to Typhoon Kalmaegi and Tropical Strom Fung-Wong. Before: Sep. 12 (a); during: Sep.
15 (b), Sep. 16 (c), Sep. 19 (d), Sep. 20 (e), Sep. 21 (f); after: Sep. 24 (g), Sep. 27 (h)



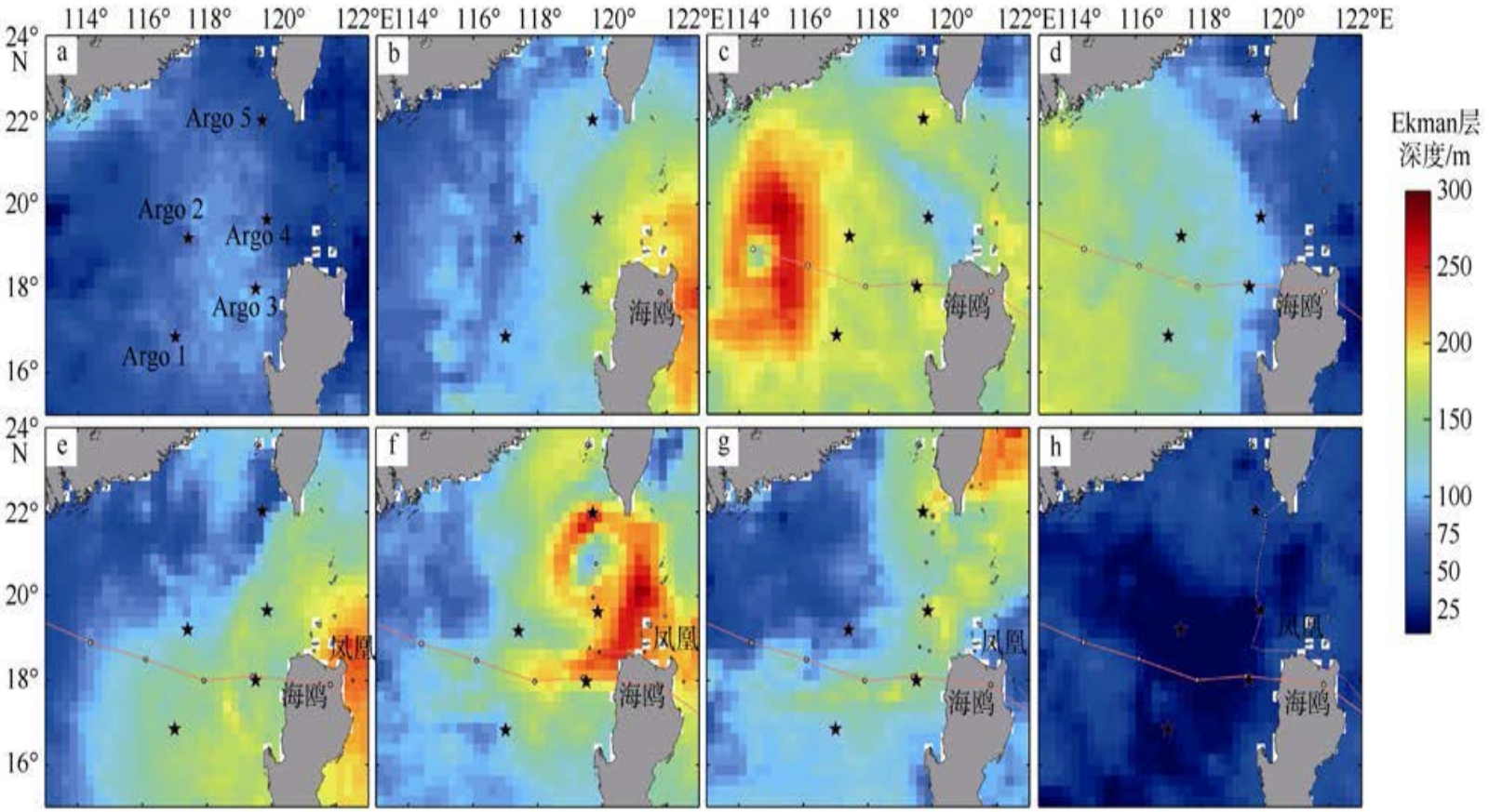
During the processes of Kalmaegi (201415) and Fung-Wong (201416) in 2014, vertical profiles of temperature (solid
lines) and salinity (dashed lines) within the depth of 200 m were derived from five Argos at different times: Sep. 11~12 (a),
Sep. 15~16 (b), Sep. 19~20 (c), Sep. 23~24 (d), Sep. 27 (e), and the time difference in every figure was within 24 hours



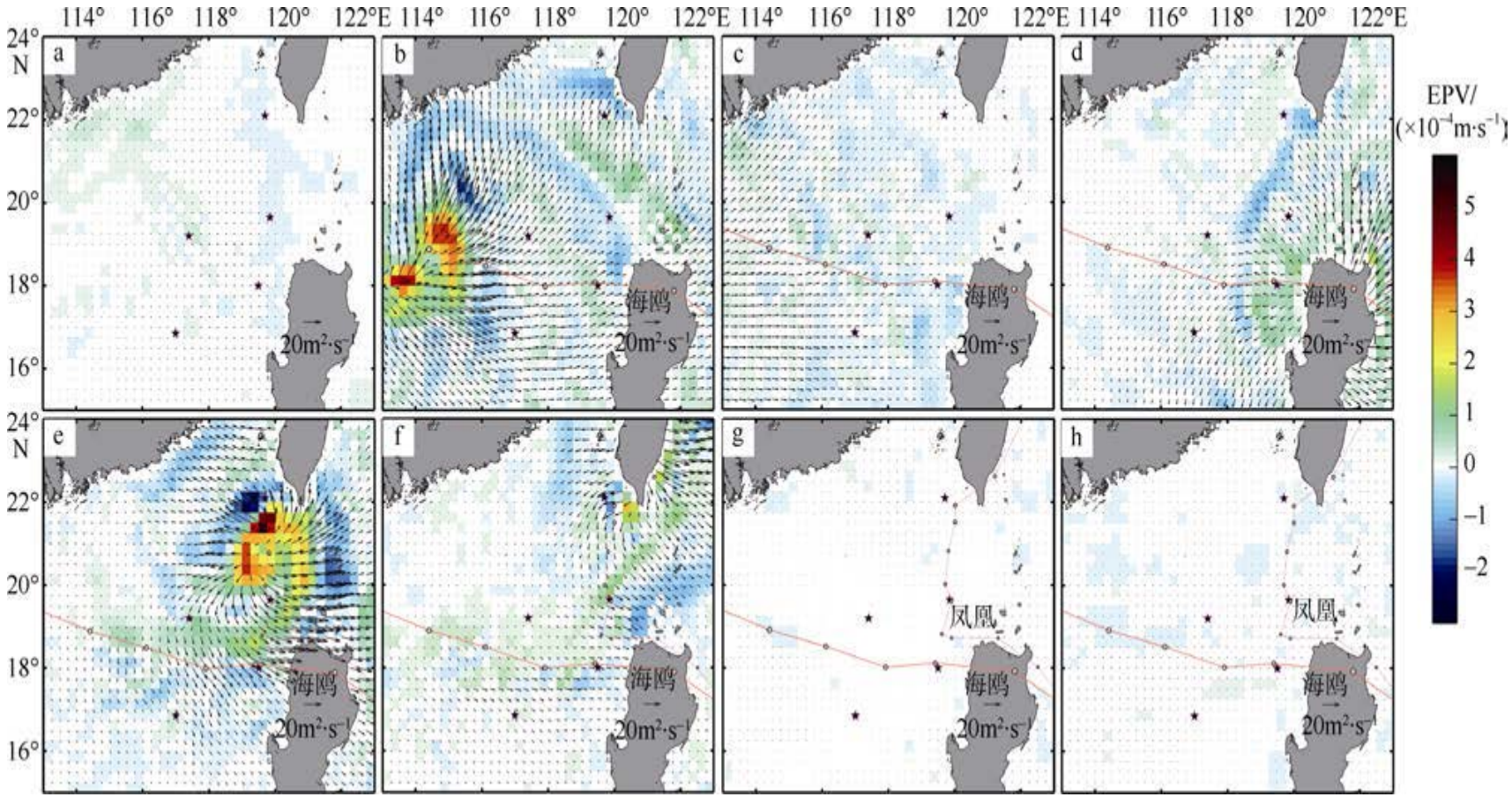
Changes of MLD, temperature (b) and salinity (c) within the mixed layer derived from Argo 5 at different times,
during the processes of Typhoon Kalmaegi (201415) and Tropical Strom Fung-Wong (201416) in 2014. Arrows indicate the
time when Fung-Wong passed the Luzon Strait, black dots in b and c are the mean values of temperature and salinity in the
mixed layer, respectively



The sea surface net heat flux (units: W·m–2, positive upward) during Typhoon Kalmaegi (201415) and Tropical Strom
Fung-Wong (201416) in 2014. Before: Sep. 12 (a); during: Sep. 15 (b), Sep. 16 (c), Sep. 19 (d), Sep. 20 (e), Sep. 21 (f); after:
Sep. 24 (g), Sep. 27 (h)

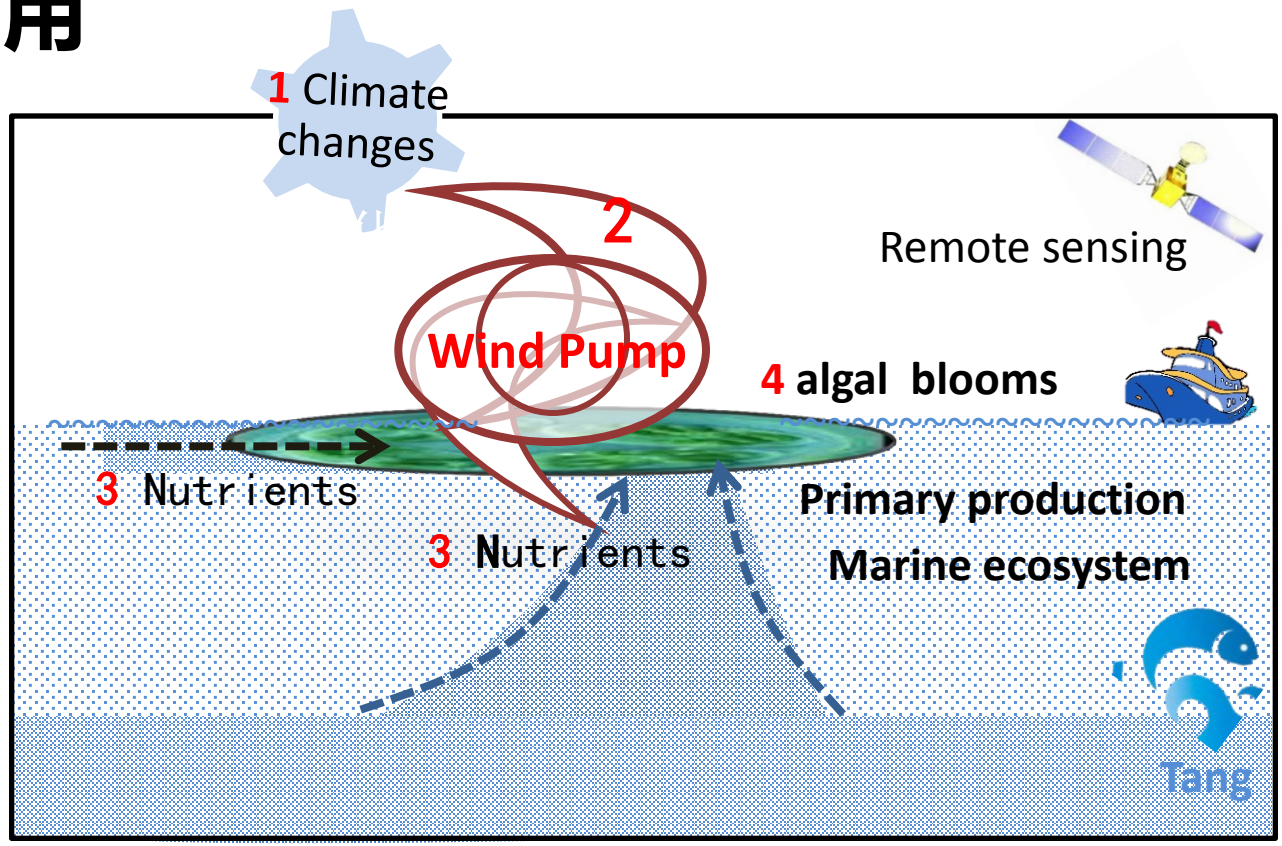


Changes of Ekman layer depth in responses to Typhoon Kalmaegi (201415) and Tropical Strom Fung-Wong (201416).
Before: Sep. 12 (a); during: Sep. 14 (b), Sep. 15 (c), Sep. 16 (d), Sep. 19 (e), Sep. 20 (f), Sep. 21 (g); after: Sep. 24 (h)



Changes of Ekman transport (vector) and Ekman pumping velocity (color shading) in the Ekman layer during Typhoon Kalmaegi (201415) and Tropical Strom Fung-Wong (201416) in 2014. Before: Sep. 12 (a); during: Sep. 15 (b), Sep. 16 (c), Sep. 19 (d), Sep. 20 (e), Sep. 21 (f); after: Sep. 24 (g), Sep. 27 (h)

风泵作用



influence Drive Control Chang e

Climate → "wind pump" → Nutrient → algal bloom → Primary production →

Respond

Wind driven algal bloom in the open oceans

能量传递

DanLing TANG (lingzis)

Thank You!

South China Sea Institute of Oceanology

Chinese Academy of Sciences

Springer
the language of science