Current and Future Activities Relevant to FUTURE in China

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Outline

1. National police support
2. Typical case for marine ecosystem
3. Typical case for model development
4. Summary

1. National police support

- Chinese National Development Strategy on Marine Science and Technology (2011-2015) /12th five-year national program on marine science and technology during.

(1)To extend ocean/climate in-situ observation and monitoring ability for improving scientific knowledge on ocean S&T ;
(2)To extend the research ability in polar oceans;
(3)To extend the research and monitoring ability in open ocean;
(4) To develop new oceanic technology for nursing ocean stragety industries;
(5)To improve ability on ocean comprehensive management through the innovation of ocean services;
(6)To deeply combine ocean research and blue economy;
(7)To enhance capacity buildings for ocean S&T;
(8)To enhance the popularization of ocean S&T.

Chinese new government led by Chair Jinping Xi and Premier Keqiangli:

The 18th chinese communist party congress pledged: (1) To improve the marine power is national strategy for China; (2) To enhance the civilization of marine ecosystem.

The above two points are so closely related with FUTURE, and will serve as the engine for Chinese scholars to take part in the activities of PICES.

2. Typical case for marine ecosystem

Since marine ecosystem research and protection is a key part of FUTURE, here we would show updated progress of marine ecosystem in China.

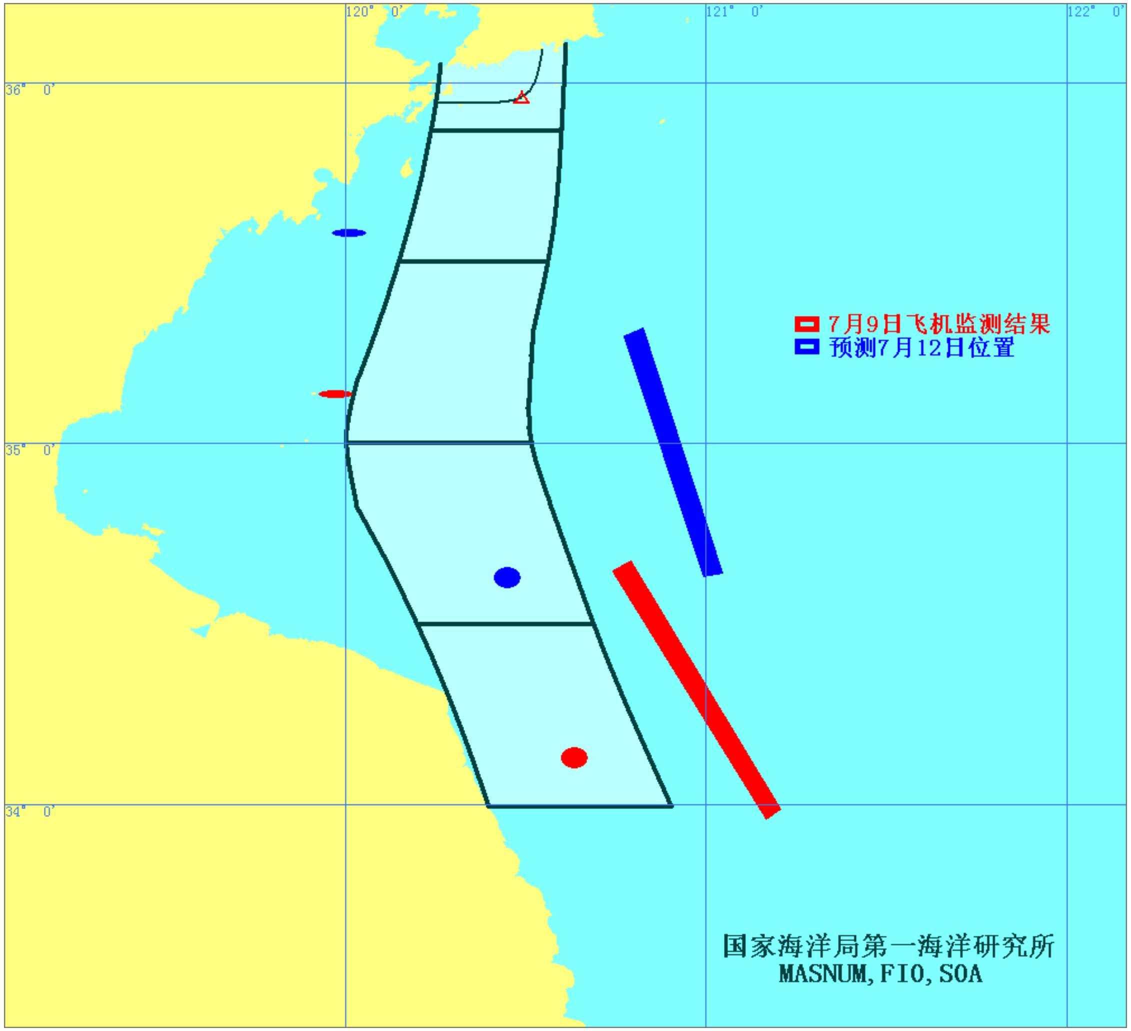
Background

Firstly noticed on May 31, 2008. And a scientific committee was formed

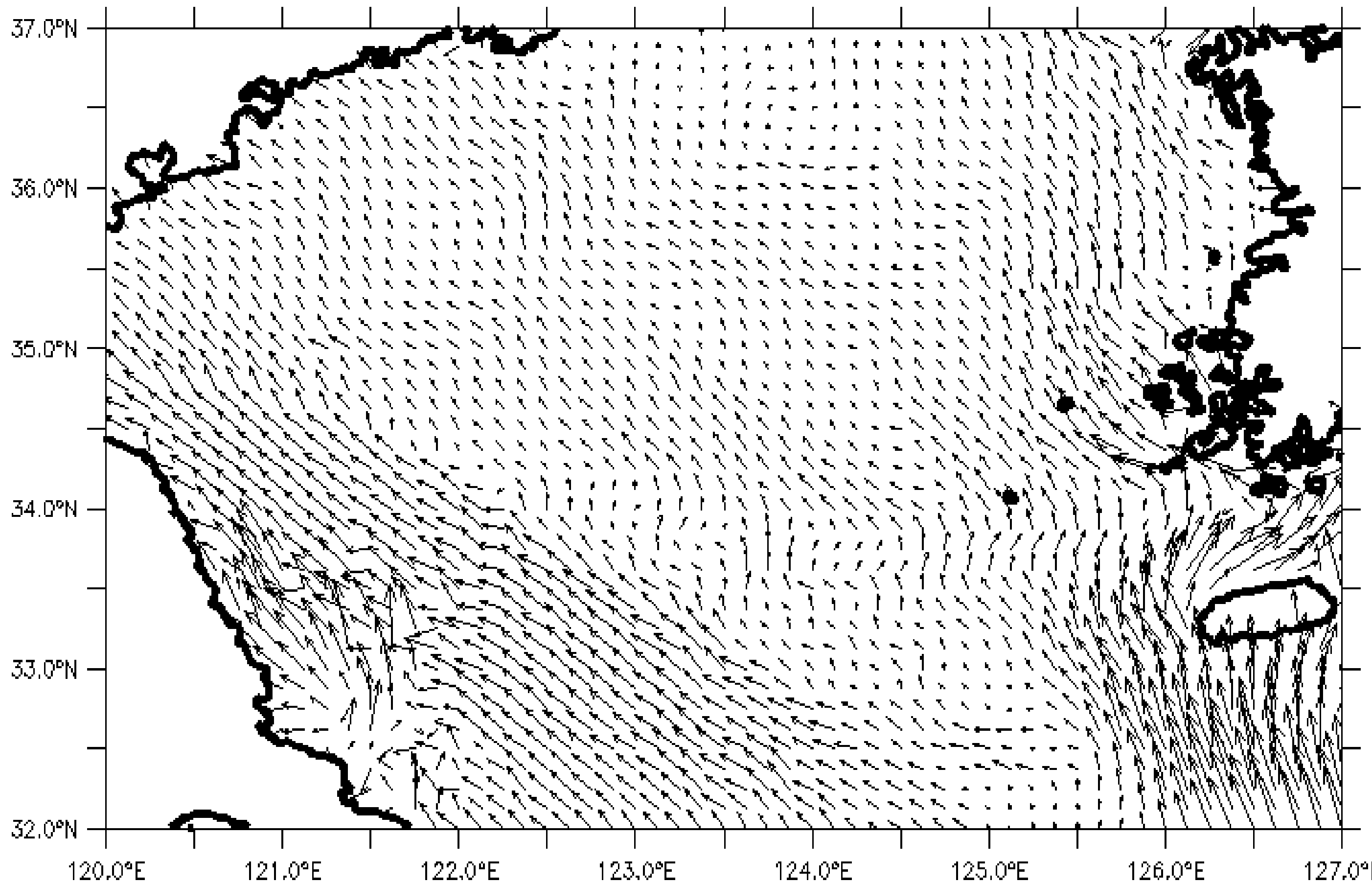
Research foci

1. **Drifting channel**
2. **Why burst (Trigger): weaken monsoon and low surface wave**
3. **Nutrient supply**
4. **Banded structure**
5. **Why accumulated in Qingdao in 2008**
6. **Sunken algea**
7. **Time window for 1800 ships**

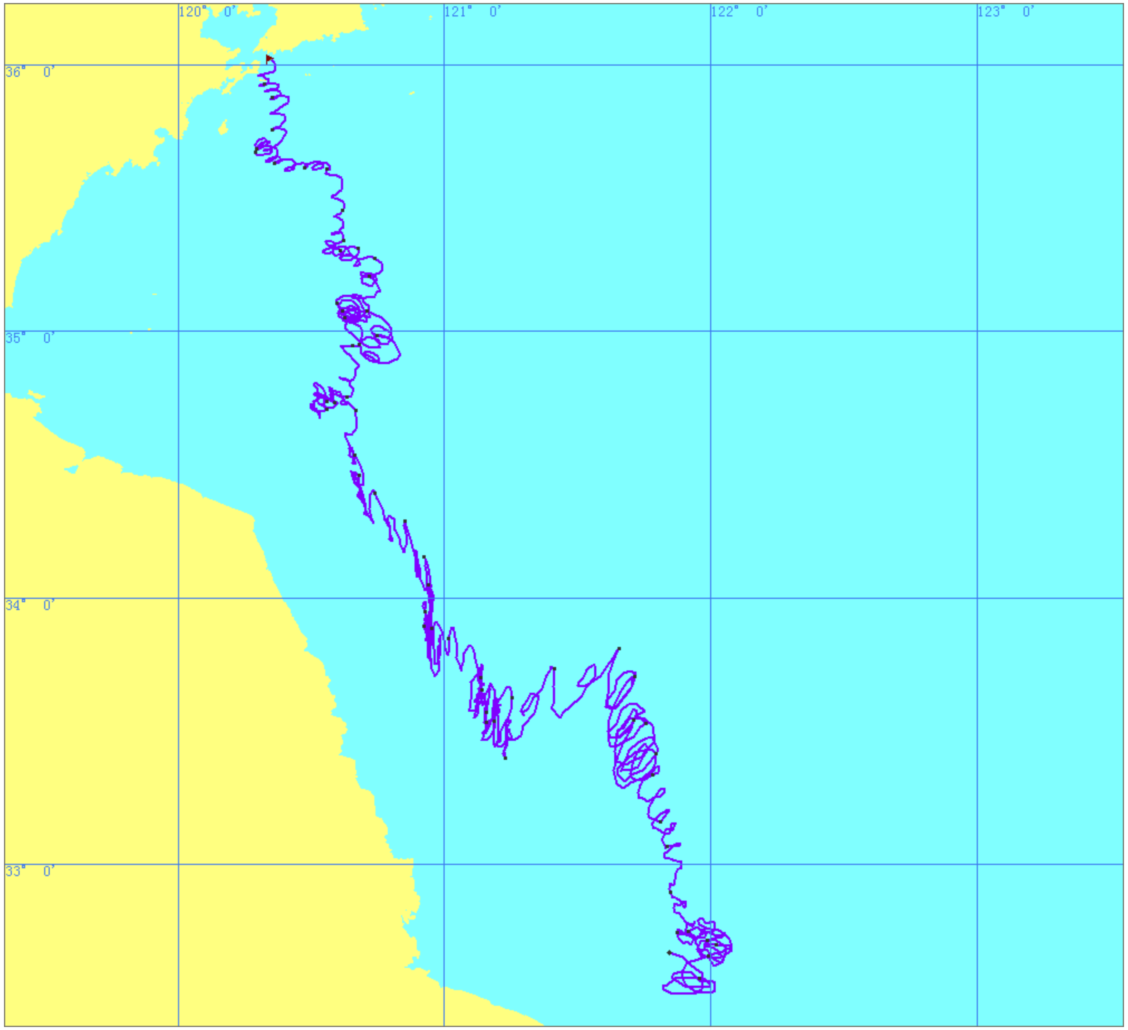
(1) Drifting Channel



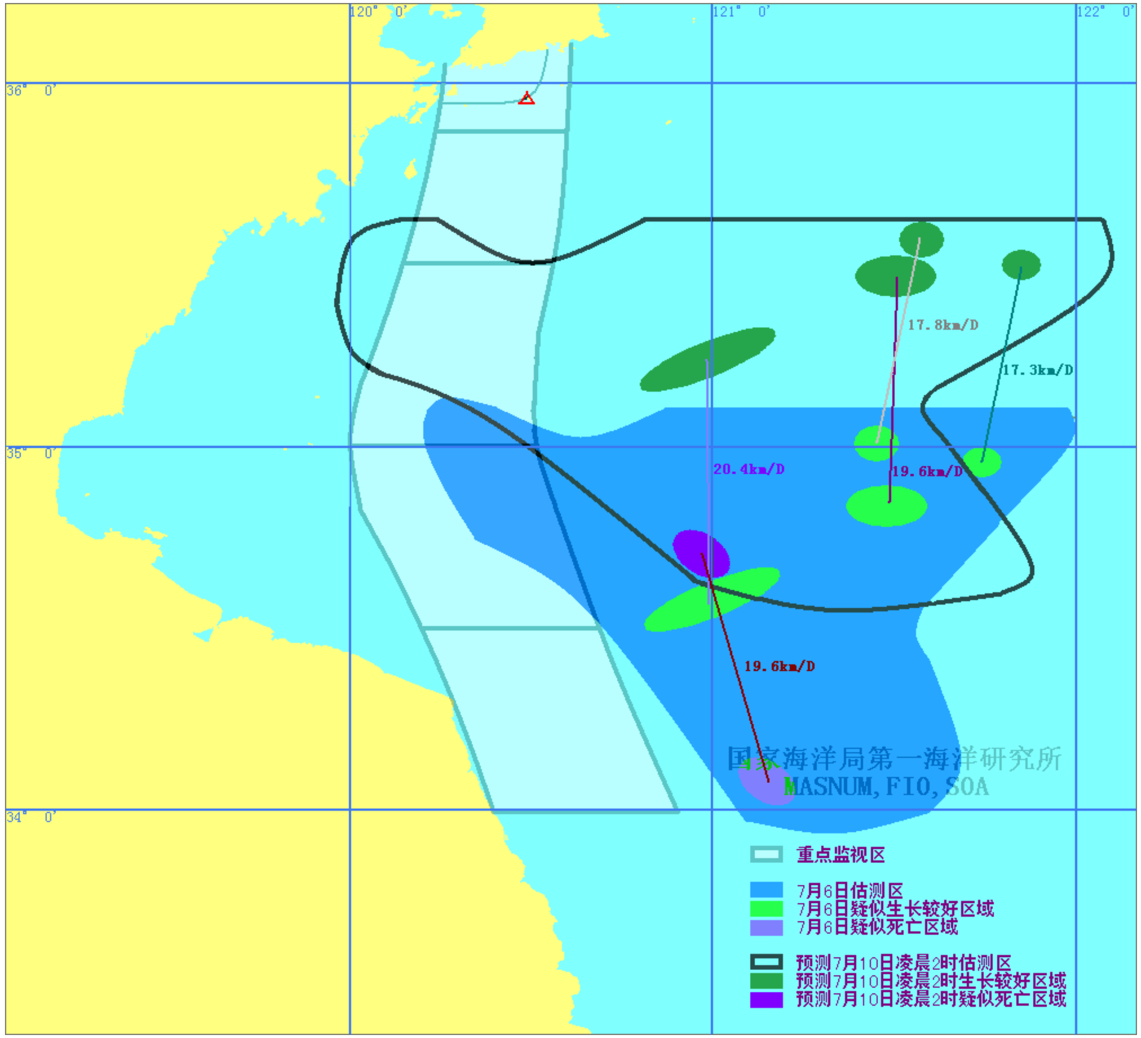
CSB, 2011



Model results of June 23,2008



Source identification from model

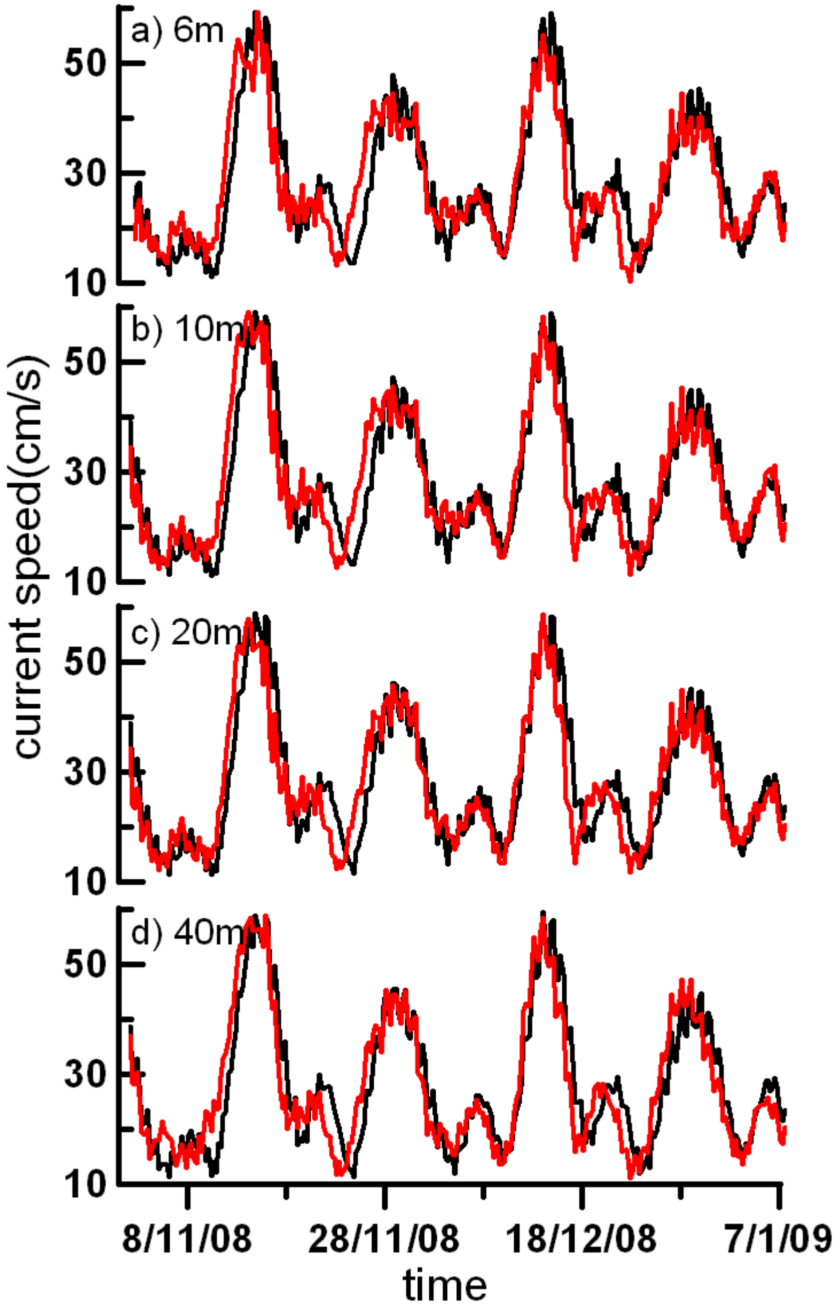


Operational application of drifting channel： This is an example of monitoring, prediction and management on July 6, 2008

Model validation

The operational forecast system at FIO

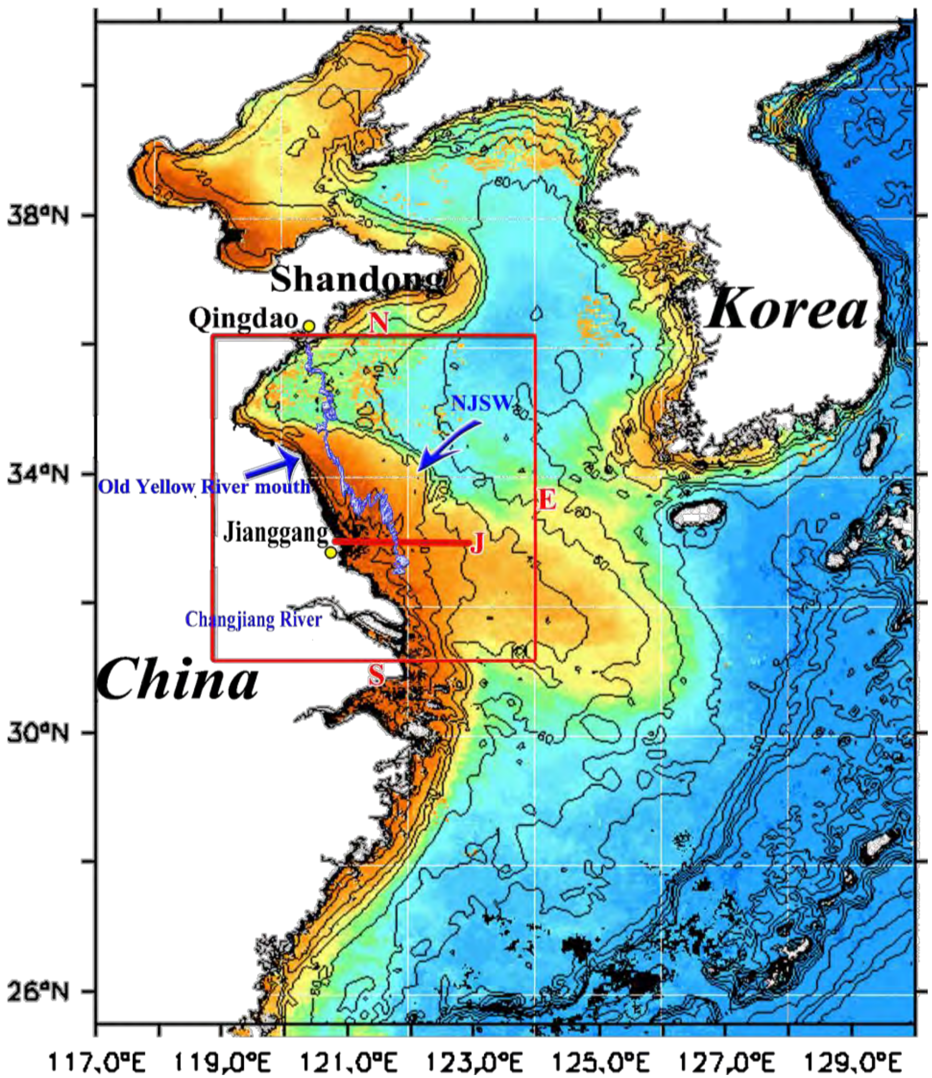
	Mean E	AME
6m：	0.5	7.8
10m：	-0.2	7.2
20m：	0.4	7.0
40m：	-0.5	6.7



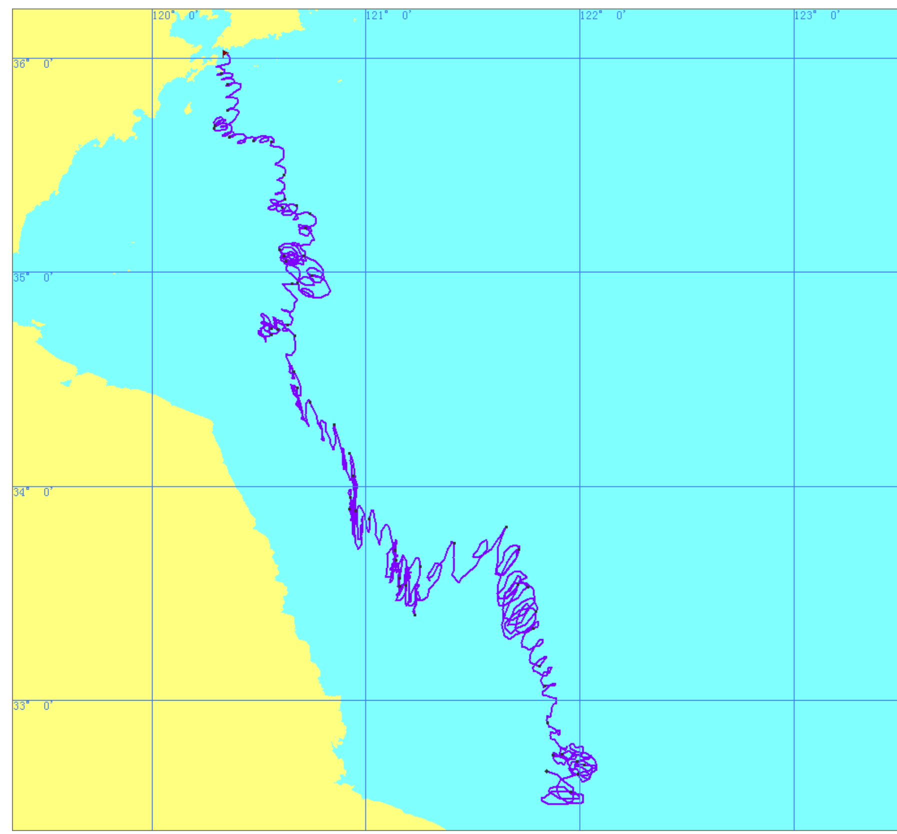
(2) Why existed in 2008

- Sediment numerical model
- The control effects on of surface wave

Wang et al, 2010, ECSS



Shandong
Qingdao
Korea
N
NJSW
Old Yellow River mouth
E
Jianggang
J
Changjiang River
China
S
38°N
34°N
30°N
26°N
117.0°E
119.0°E
121.0°E
123.0°E
125.0°E
127.0°E
129.0°E



Wave　　No wave

		MODIS (mg l^{-1})	Exp 1 (mg l^{-1})	Exp 2 (mg l^{-1})
2006	March	50.1	36.2	9.7
	April	50.9	36.4	9.3
2007	March	42.9	48.1	10.2
	April	32.7	35.8	9.4
2008	March	42.0	31.5	9.6
	April	22.9	34.6	9.4
Average	March	45.0	38.6	9.8
	April	35.5	35.6	9.4

April 2006-2008.

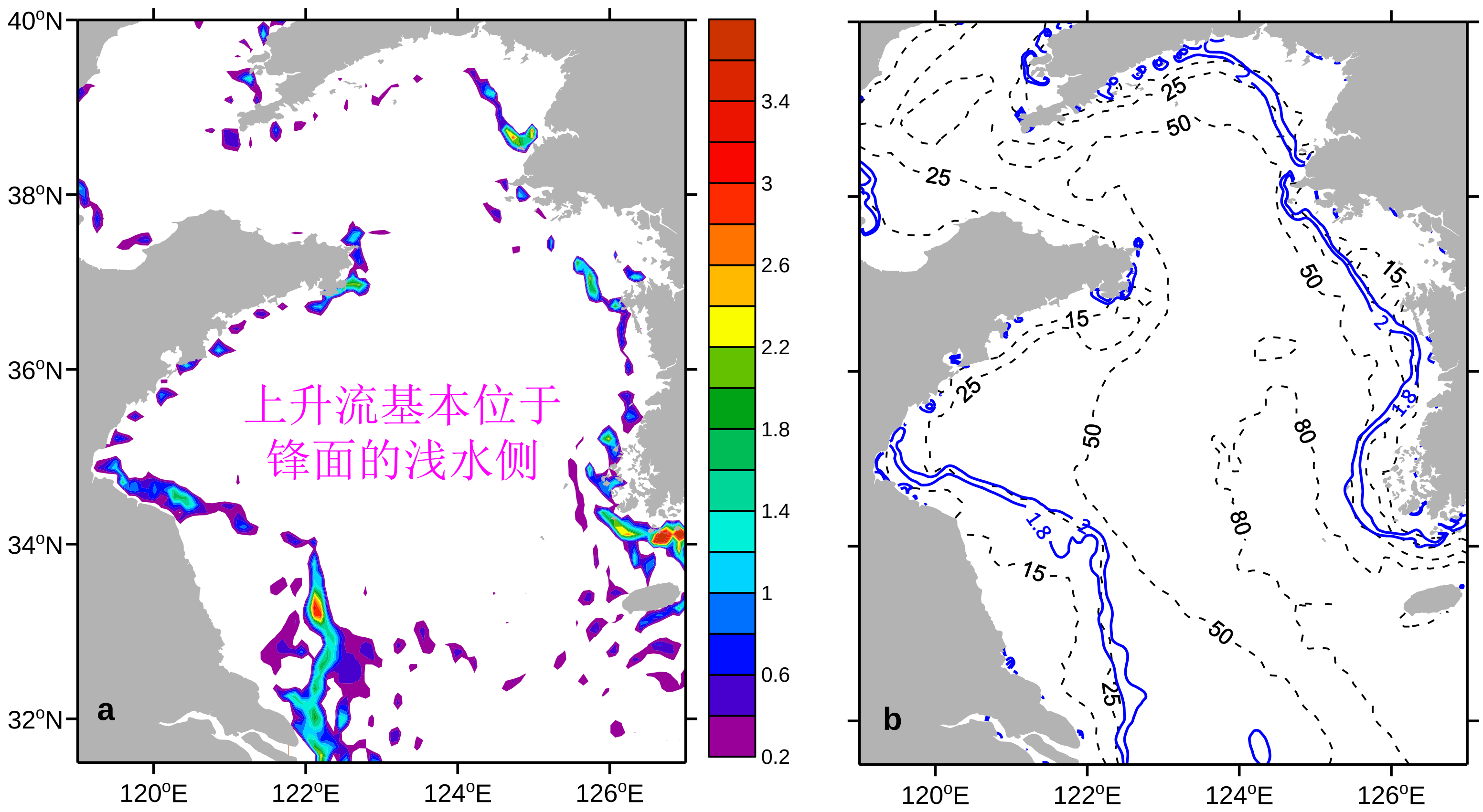
		Wind speed ($m\ s^{-1}$)	Wave amplitude (m)
2006	March	6.03	0.78
	April	6.06	0.82
2007	March	6.68	0.90
	April	5.88	0.66
2008	March	5.65	0.64
	April	5.50	0.65

(3) Nutrients supply

- **MASNUM wave-tide-circulation coupled model**
- **Upwelling should provide the main nutrient supply**

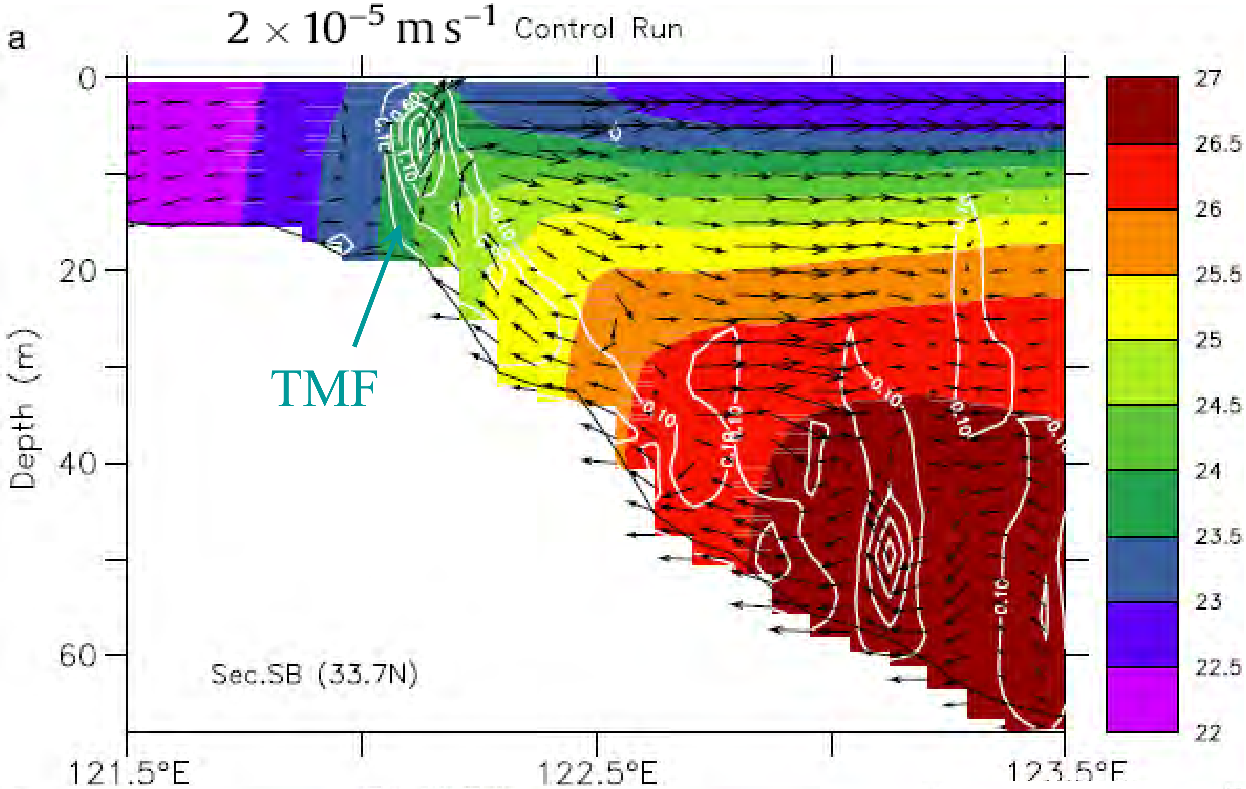
Lv et al, 2010, CSR

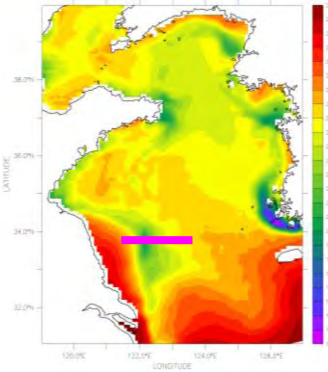
Upwelling system



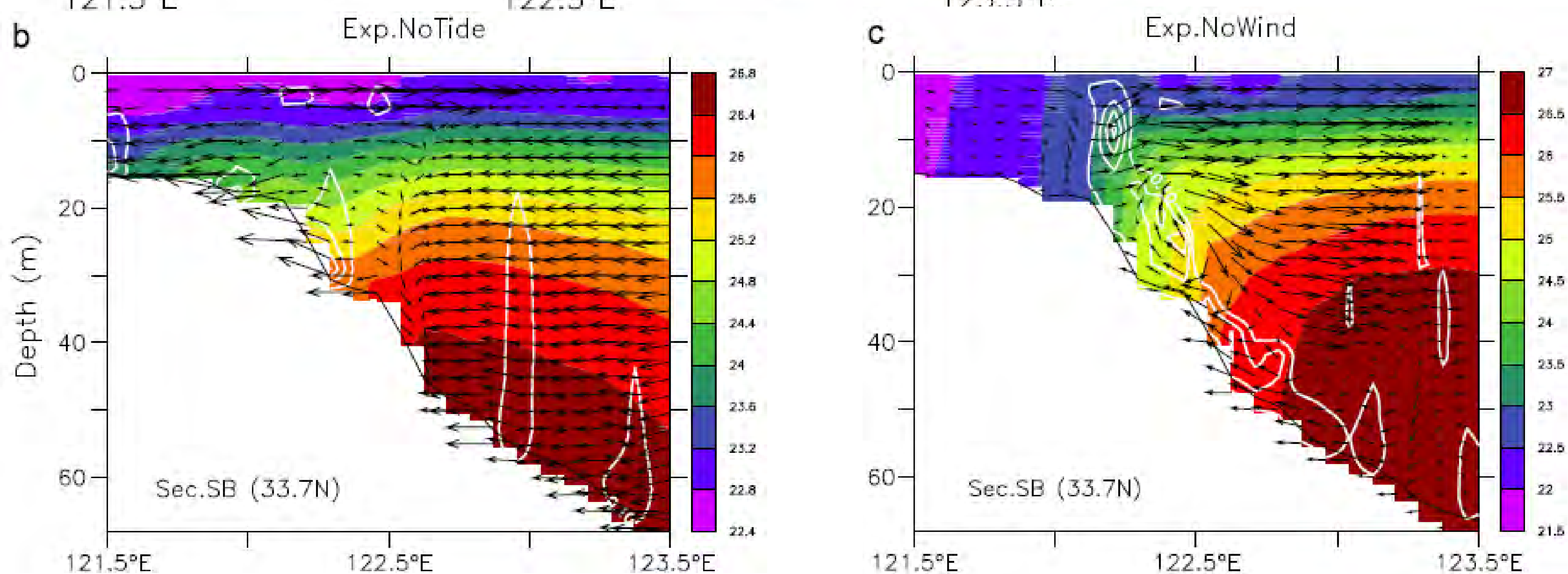
Upwelling at 10 m (10^{-5} m/s)

$$SH = \log\left(H/|u|^3\right)$$

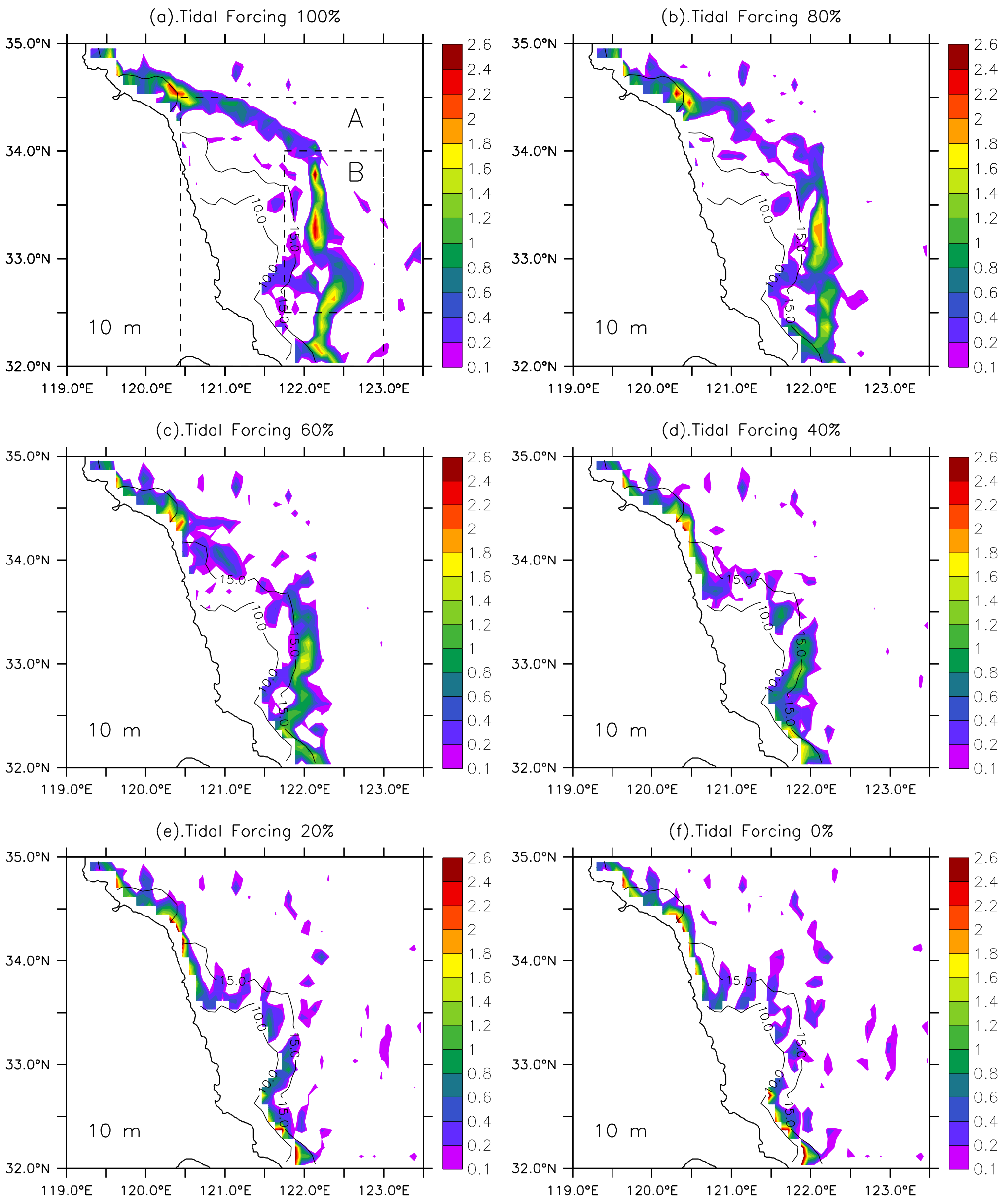


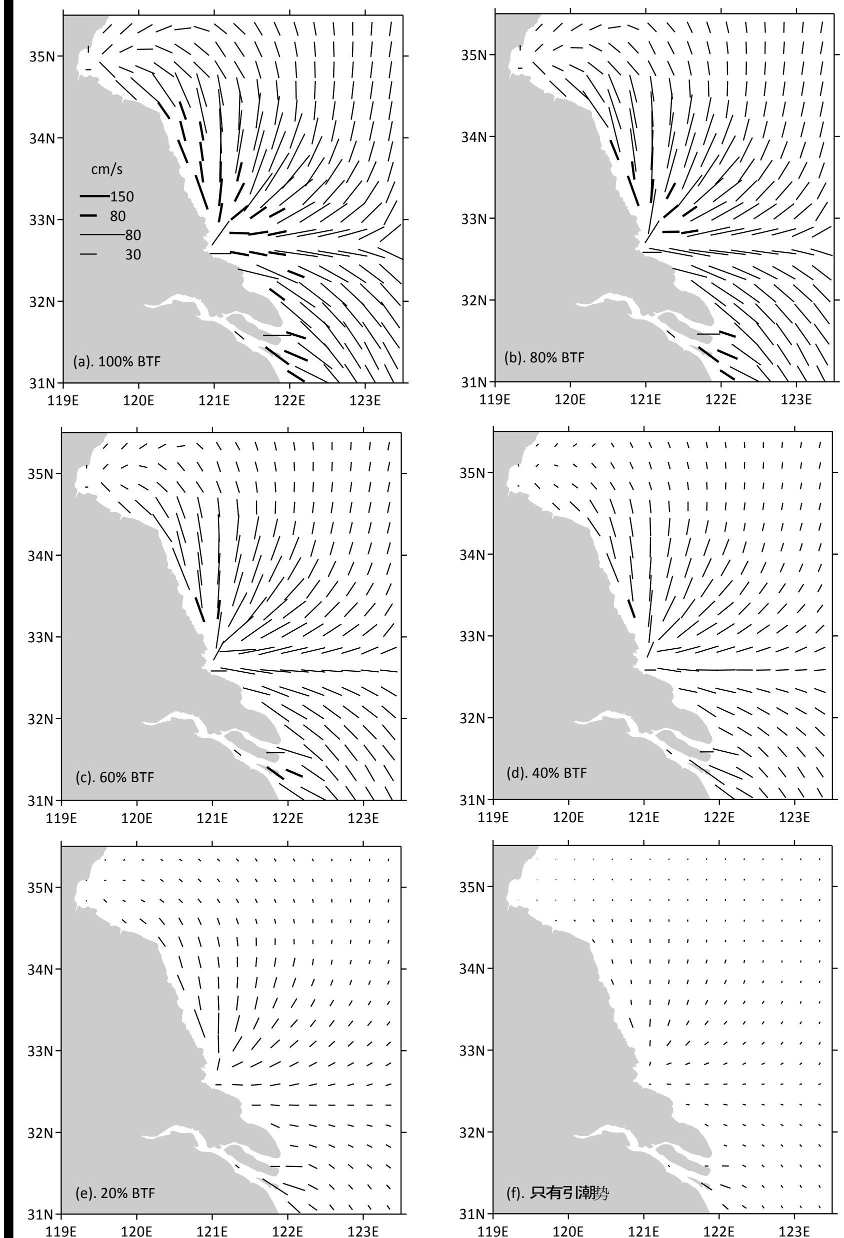


Transect structure

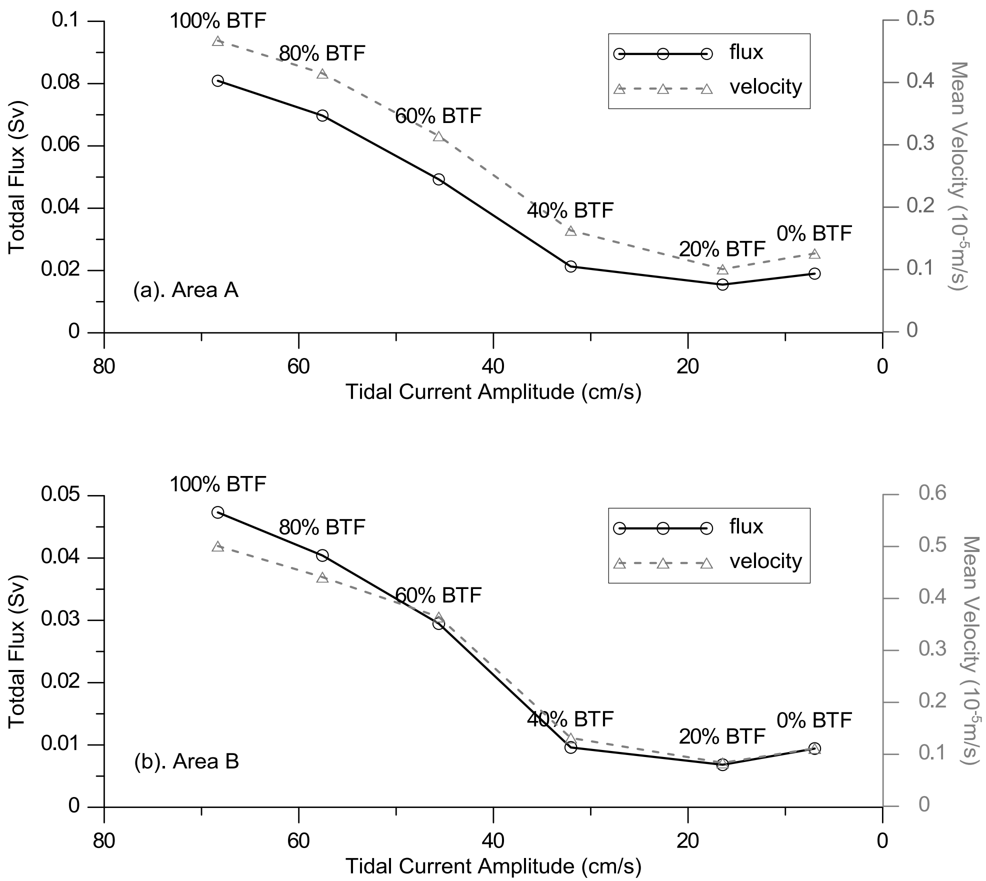


The relationship between upwelling and tide





The relationship between upwelling and tide



不同潮强迫作用下苏北外海上升流的变化曲线

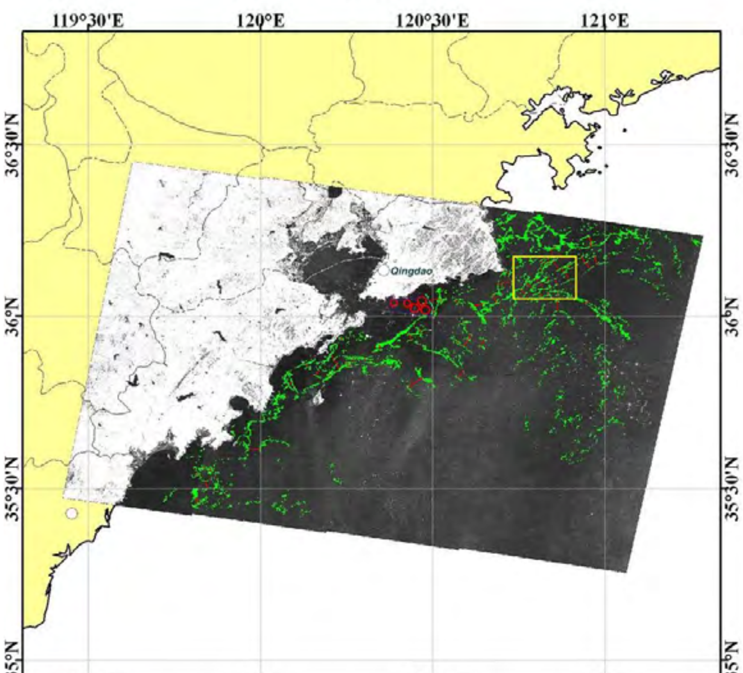
(4) Banded structure

- **Satellite data**
- **What's the image anomaly?**

Qiao et al, 2009, MPB

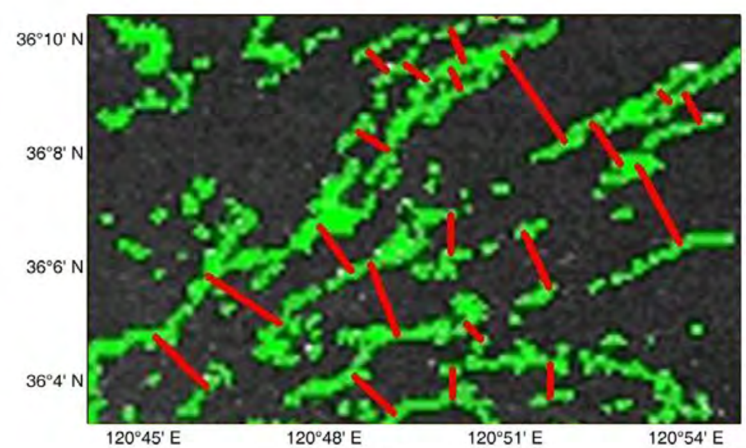
(a)

(b)

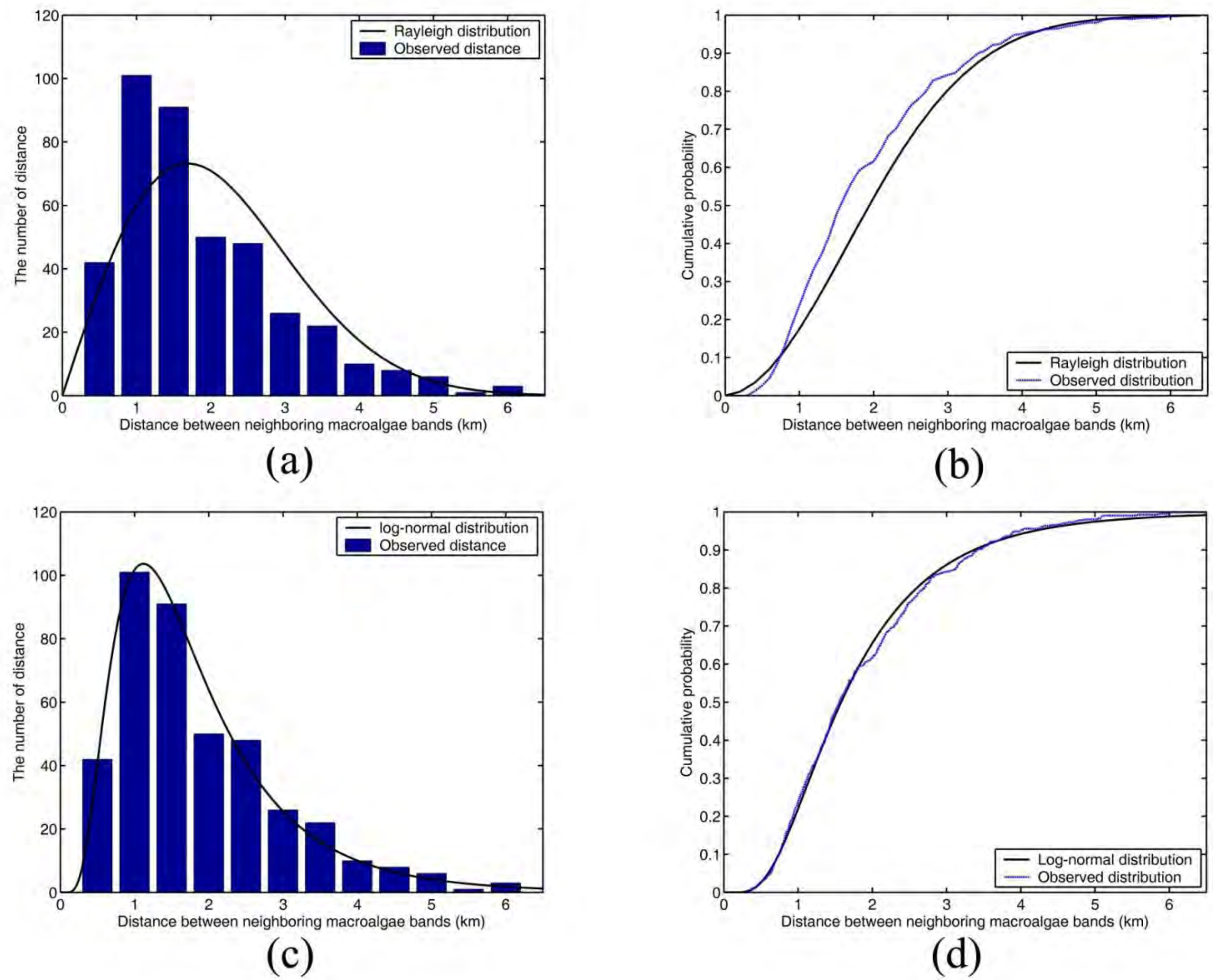


(c)

What's the anomaly?



(d)



上图：Rayleigh distribution； 下图：log-normal distribution（408）

浒苔间距1－2公里

Langmuir, I. 1938. Surface motion of water induced by wind. Science

Qiao et al, 2009, MPB

图4 Apollo photo of the Georgia Coast at 1500GMT(1000 local time) on 4 April 1968,from a height of 125 mi. The cloud streets are over the land, aligned approximately with the geostrophic wind which is due north. They begin about 16 km after landfall, and occupy an area about 200 mi^2.The rows are about 2-3 km apart at about 1 km height. (The original photograph was in color).
摘自（Brown 1970）

云 街

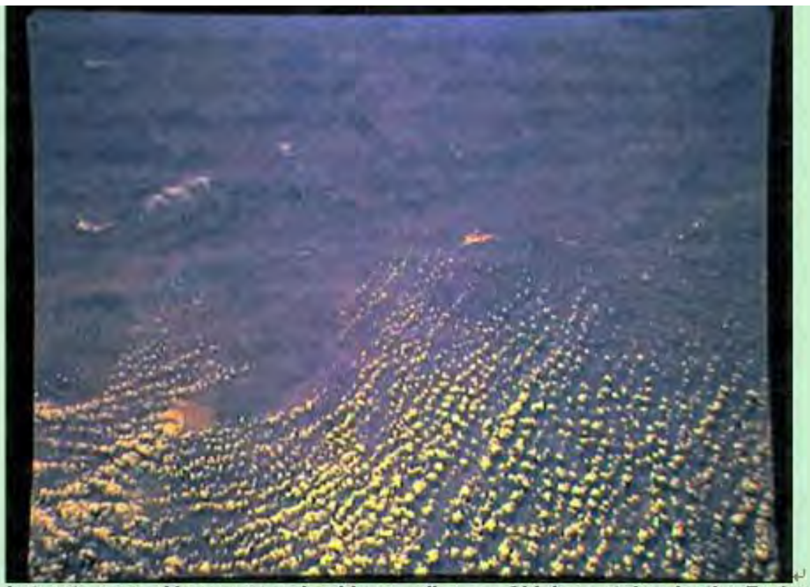
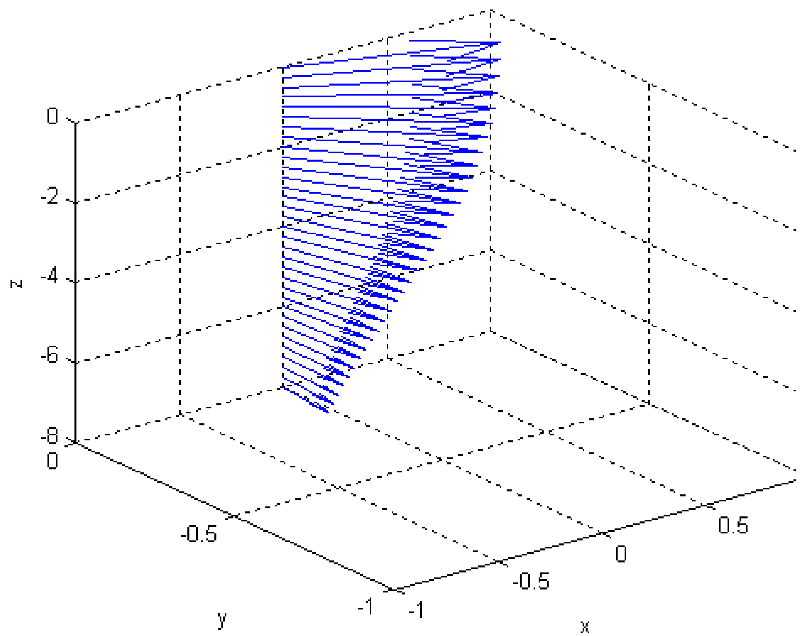
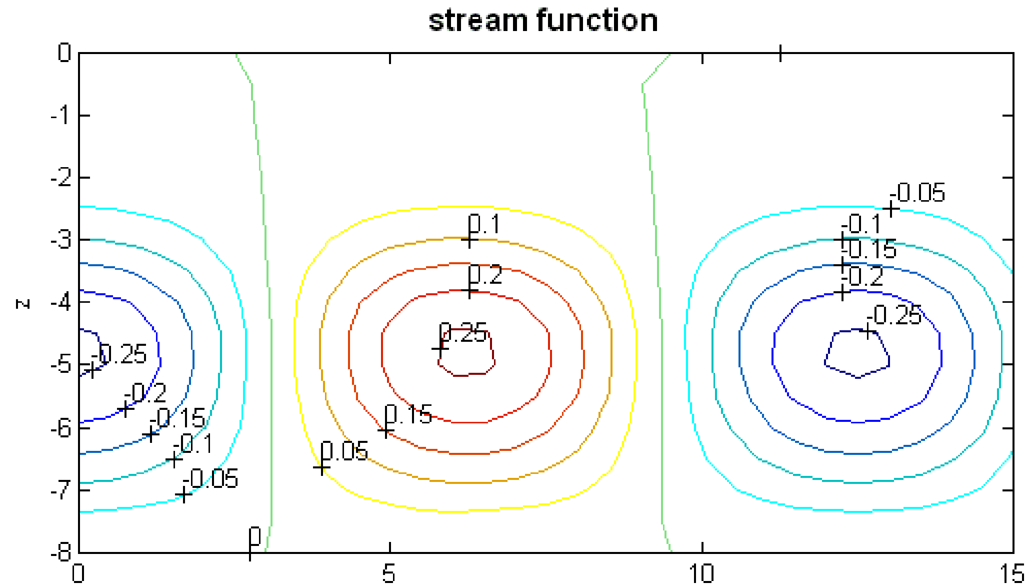


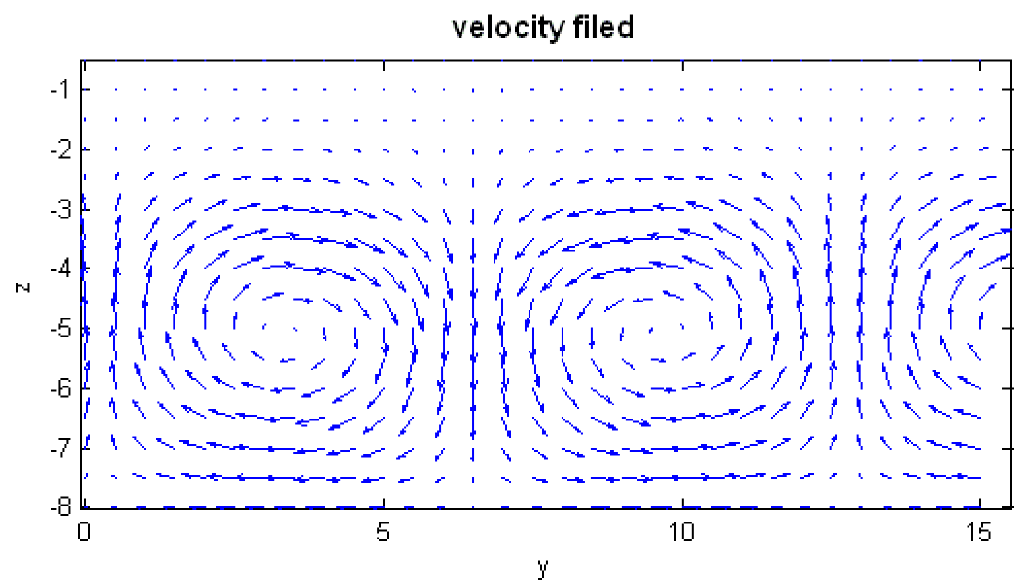
图3. Cloud streets caused by narrow mixed-layer rolls over Oklahoma,taken by the *Endeavor* crew during NASA Mission STS068. The photograph was taken at 1942 UTC at an unspecified day in early Oct 1994.(Courtesy of the Johnson Space Center JSC Digital Image Collection.)
摘自（Yong,G.D.2002）



z
y
x

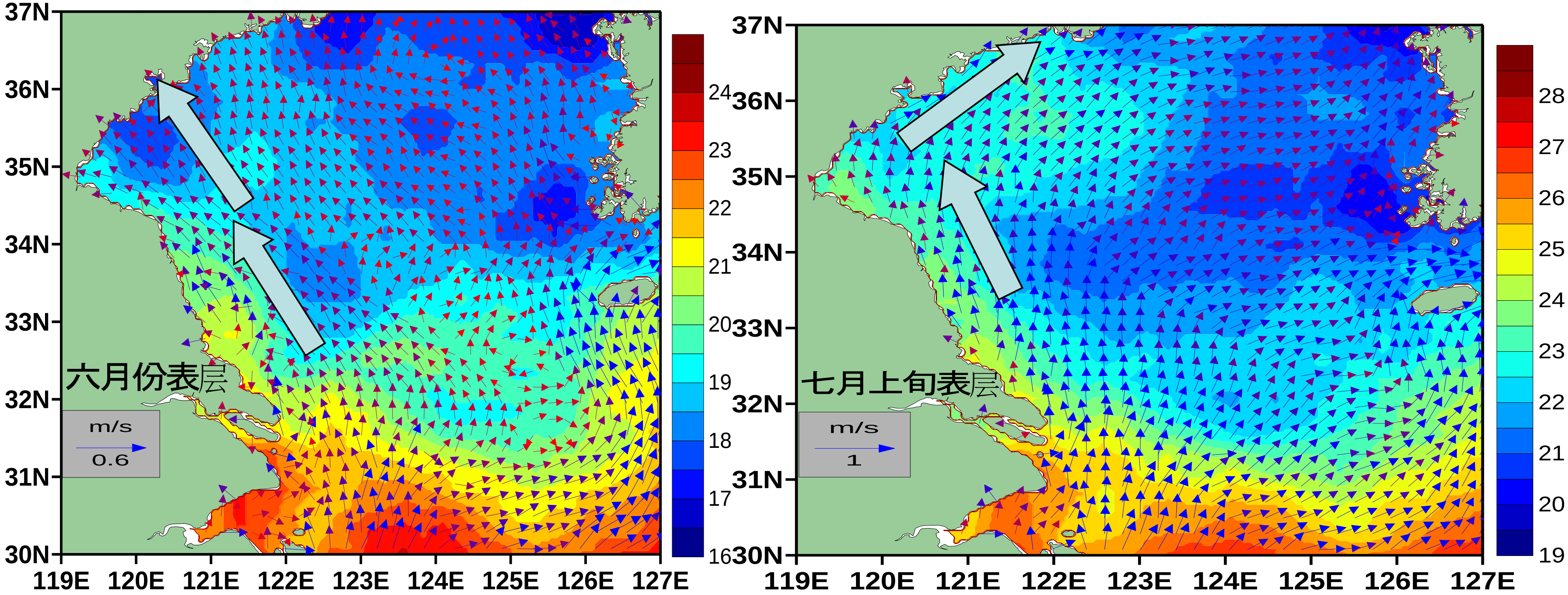


stream function
z

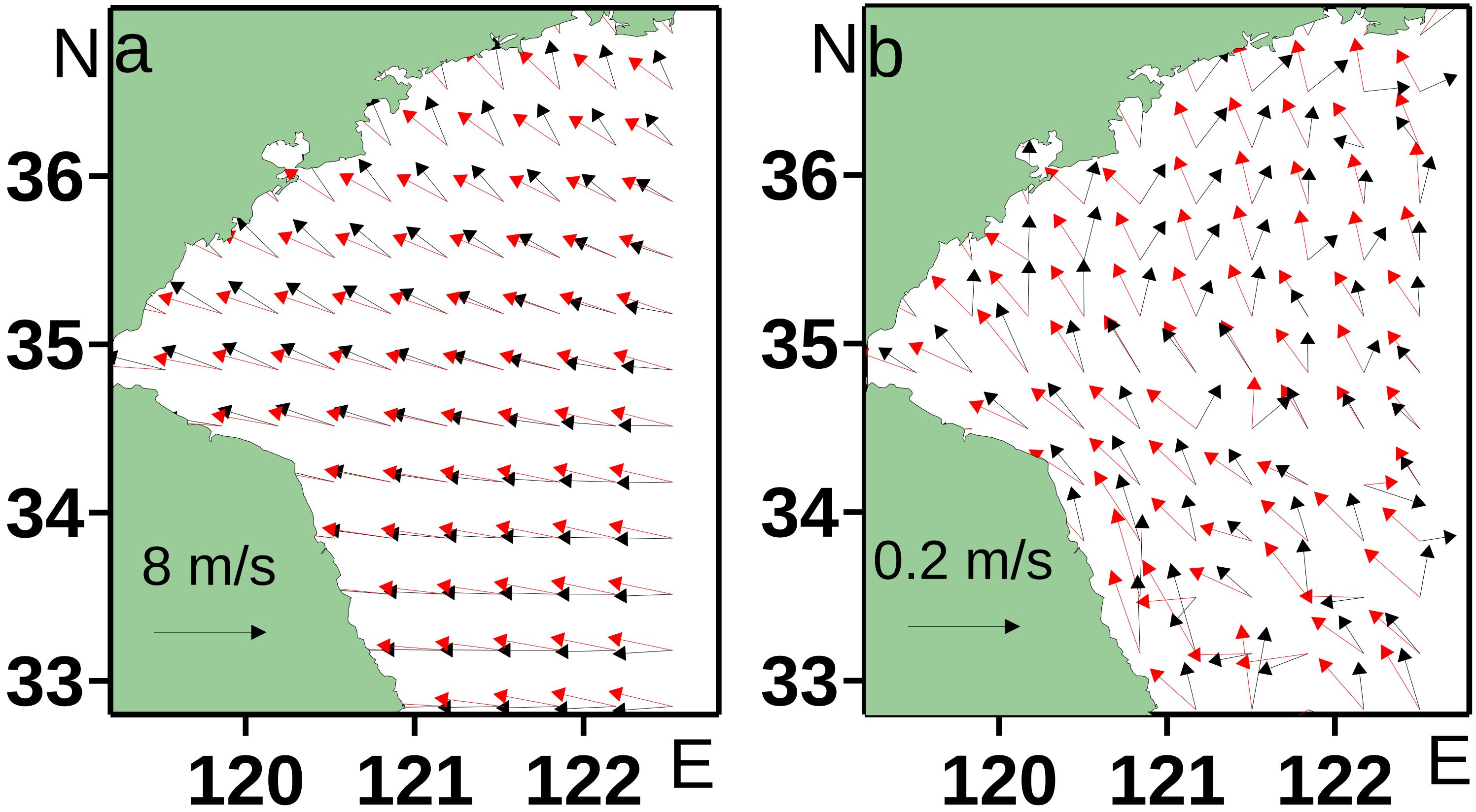


velocity filed
z
y

(5) Why accumulated in Qingdao in 2008



Simulated surface current and SST in June (left) and July 1-10 (right) 2008



The comparison between June, 2008 (red) and June 2010 (black). Left is monthly averaged wind field, and right is the ocean surface current.

We are facing other marine ecosystem challenges, such as jellyfish bloom in the Yellow Sea. Chinese central government has paid lots of attentions on these challenges.

Sun S

The variations of fishery products and environmental effects of marine agriculture

The biological effects of hypoxia zone entension

3. Typical case for model development

The importance of improving forecasting ability for FUTURE

$$B_V = \alpha \iint_{\vec{k}} E(\vec{k}) \exp\{2kz\}\, d\vec{k}\, \frac{\partial}{\partial z}\left(\iint_{\vec{k}} \omega^2 E(\vec{k}) \exp\{2kz\}\, d\vec{k} \right)^{1/2}$$

E(K) is the wave number spectrum which can be calculated from a wave numerical model. It will change with (x, y, t), so Bv is the function of (x, y, z, t).

Yuan et al, 1999; Qiao et al, GRL, 2004; OD, 2010

If we regard surface wave as a monochramatic wave,

$$B_v = \alpha A^3 k \omega e^{(-3kz)} = \alpha A u_s e^{(-3kz)} ,$$

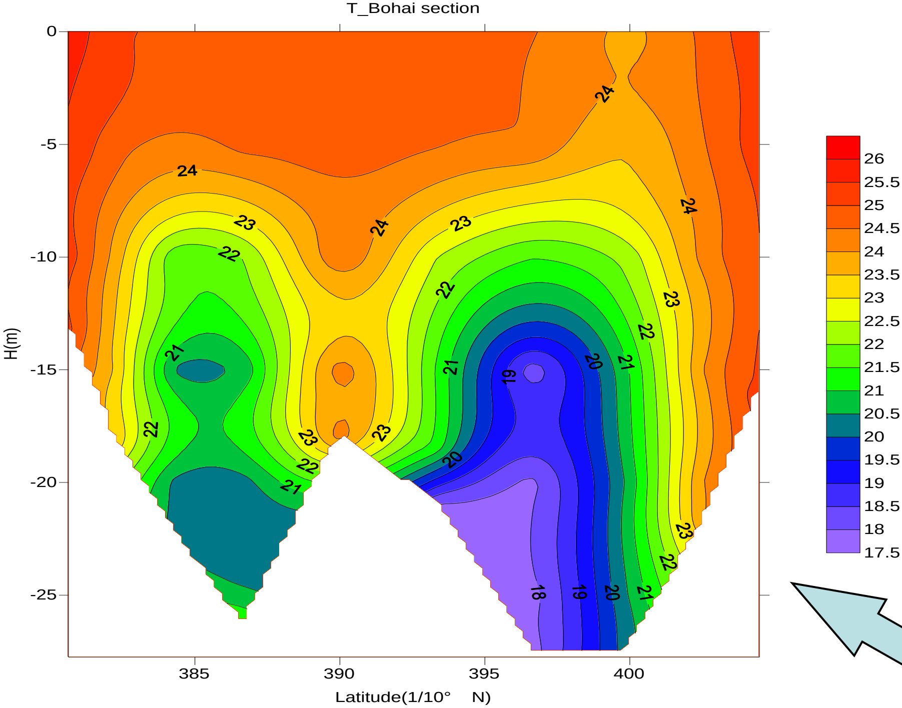
Stokes Drift

Bv is wave motion related vertical mixing instead of wave breaking.

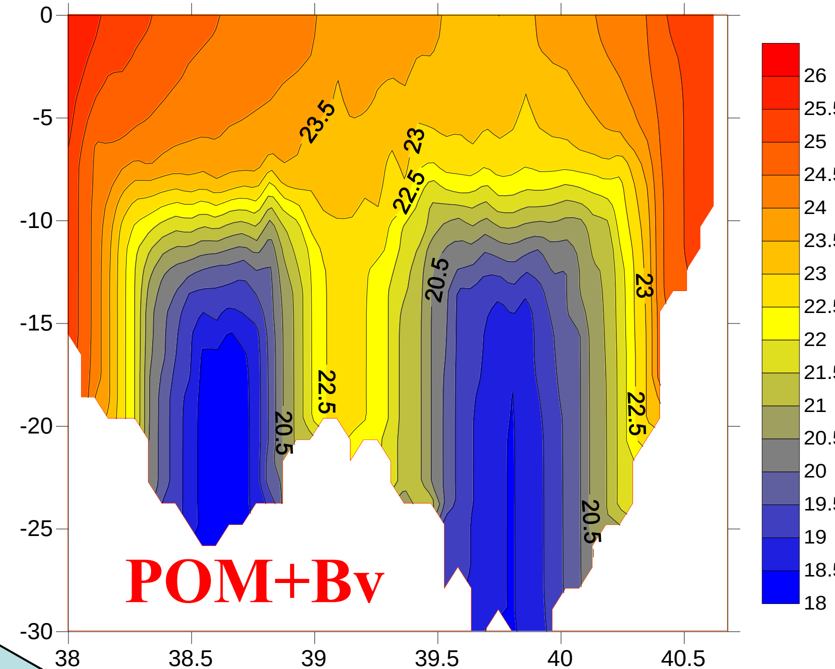
Although the horizontal scale of surface wave, 100m, is much smaller than that of circulation, however, the wave-induced vertical velocity in the upper ocean could be stronger than vertical current turbulence velocity.

Challenge 1

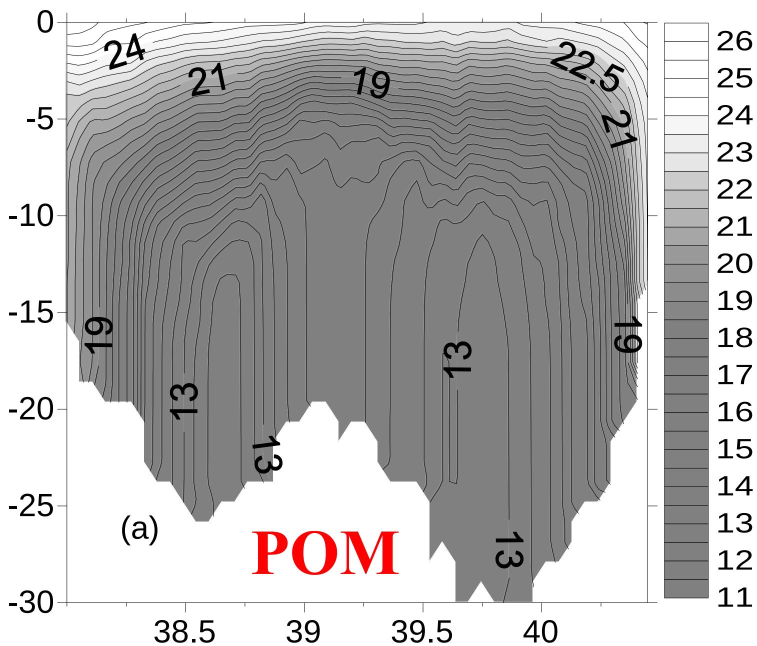
(1) OGCMs: Simulated SST is overheating in summertime, and mixed layer depth is too shallow while the thermocline is too weak (Martin 1985, Kantha 1994, Ezer 2000, Mellor 2003).

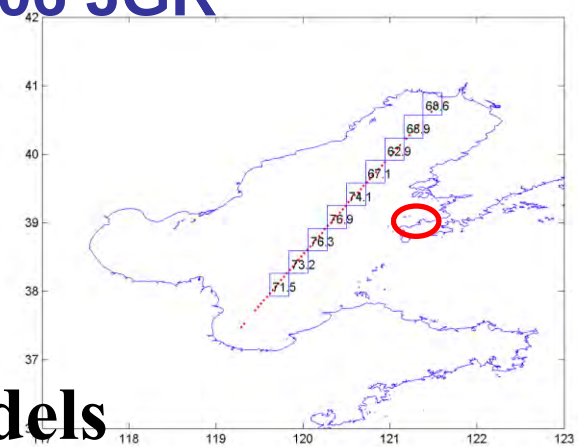


Observation in summer



Lin et al, 2006 JGR



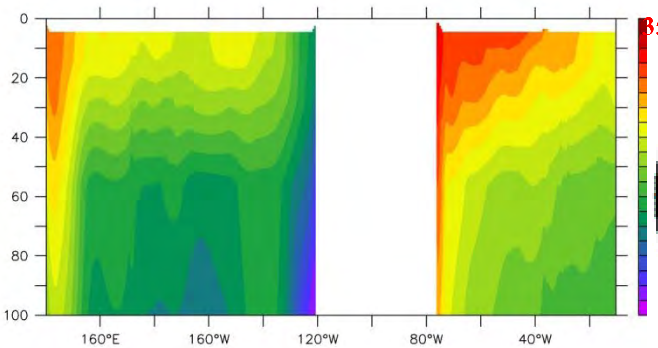


3-D coastal models

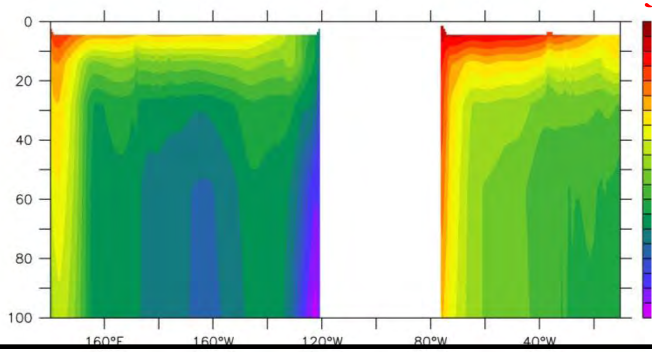
Vertical Temperature Distributions

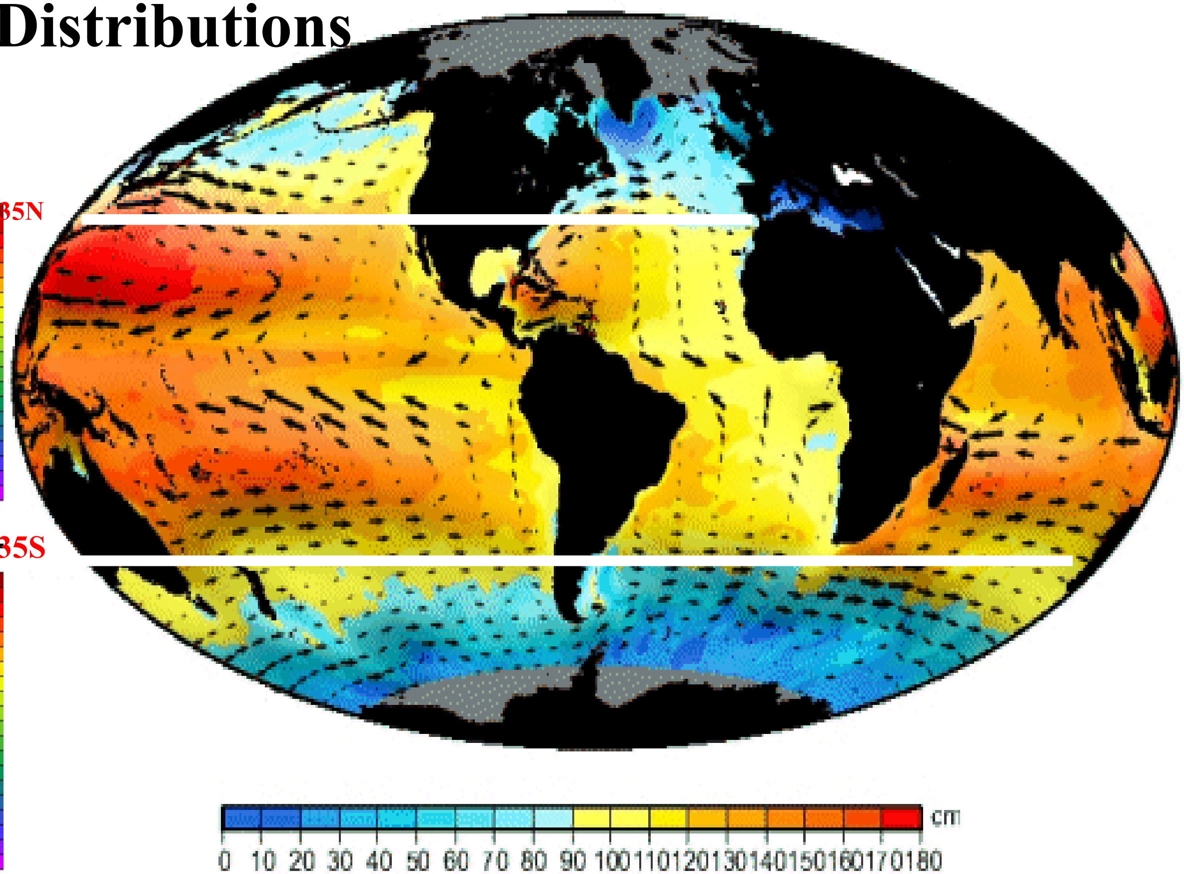
Pacific **Atlantic**

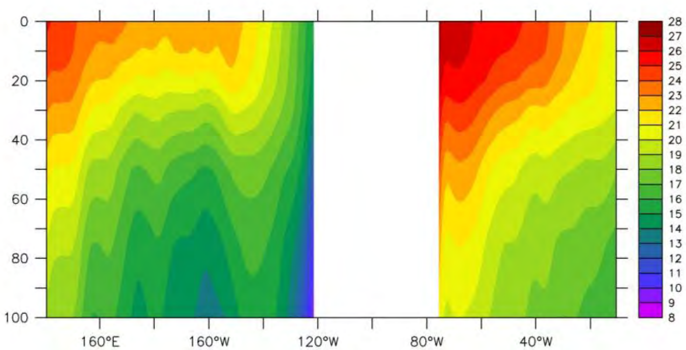
35N

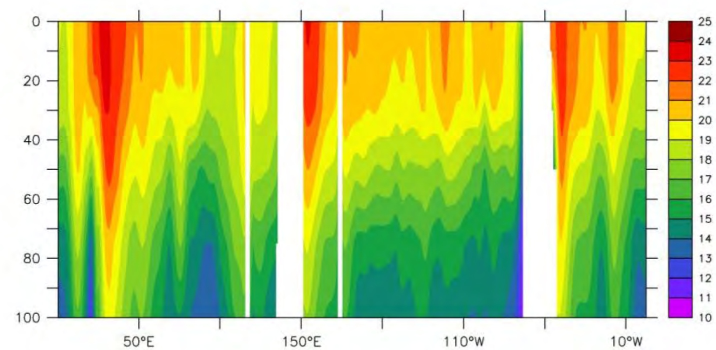


35S



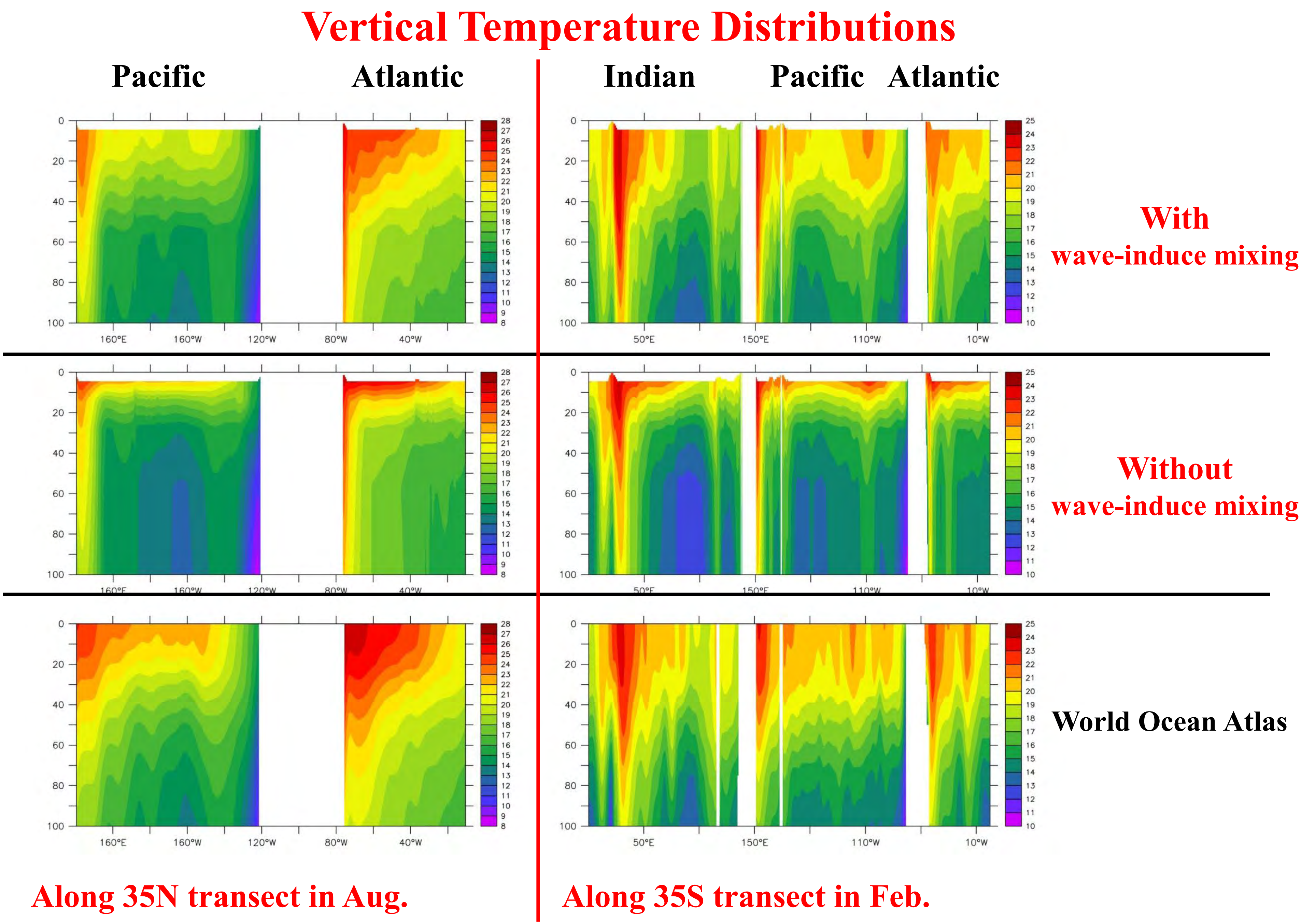






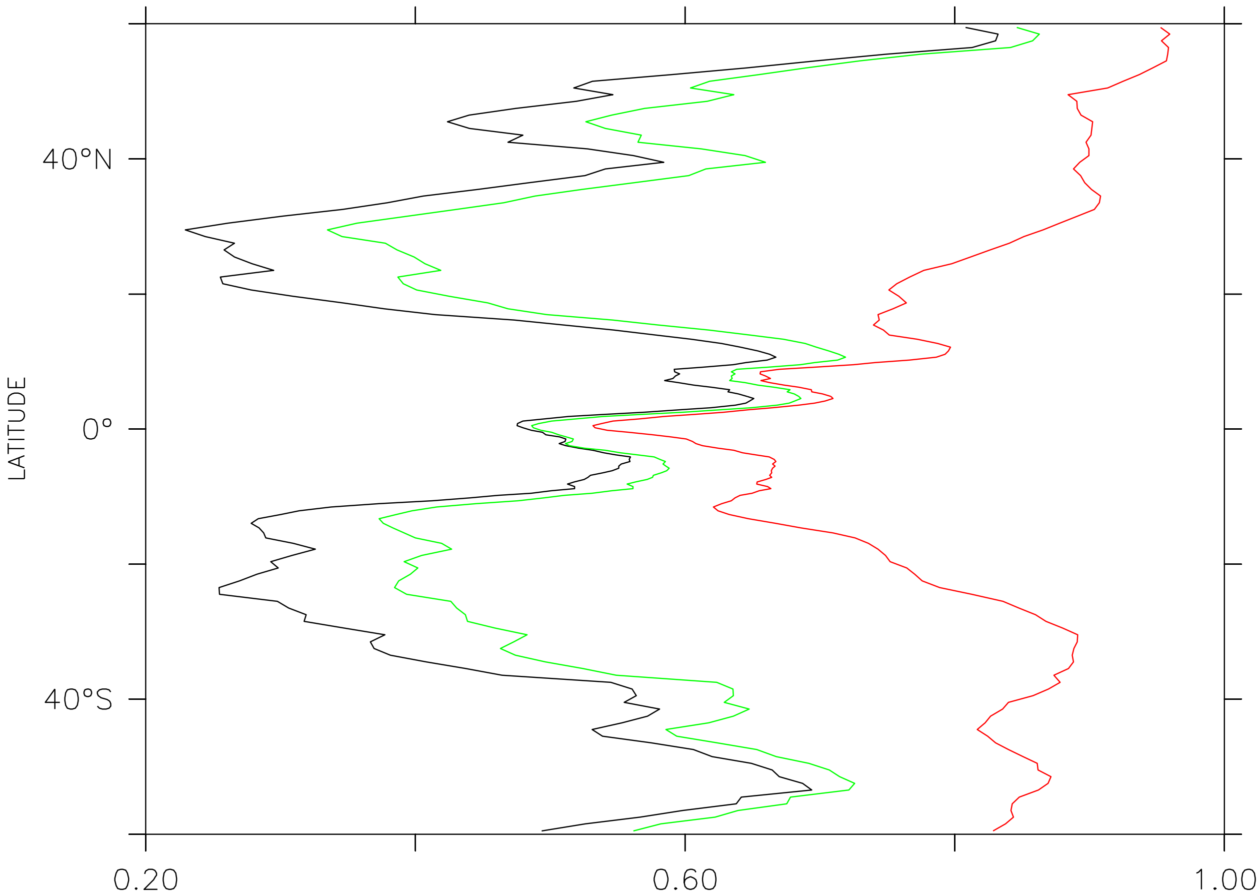
World Ocean Atlas

Along 35N transect in Aug. **Along 35S transect in Feb.**

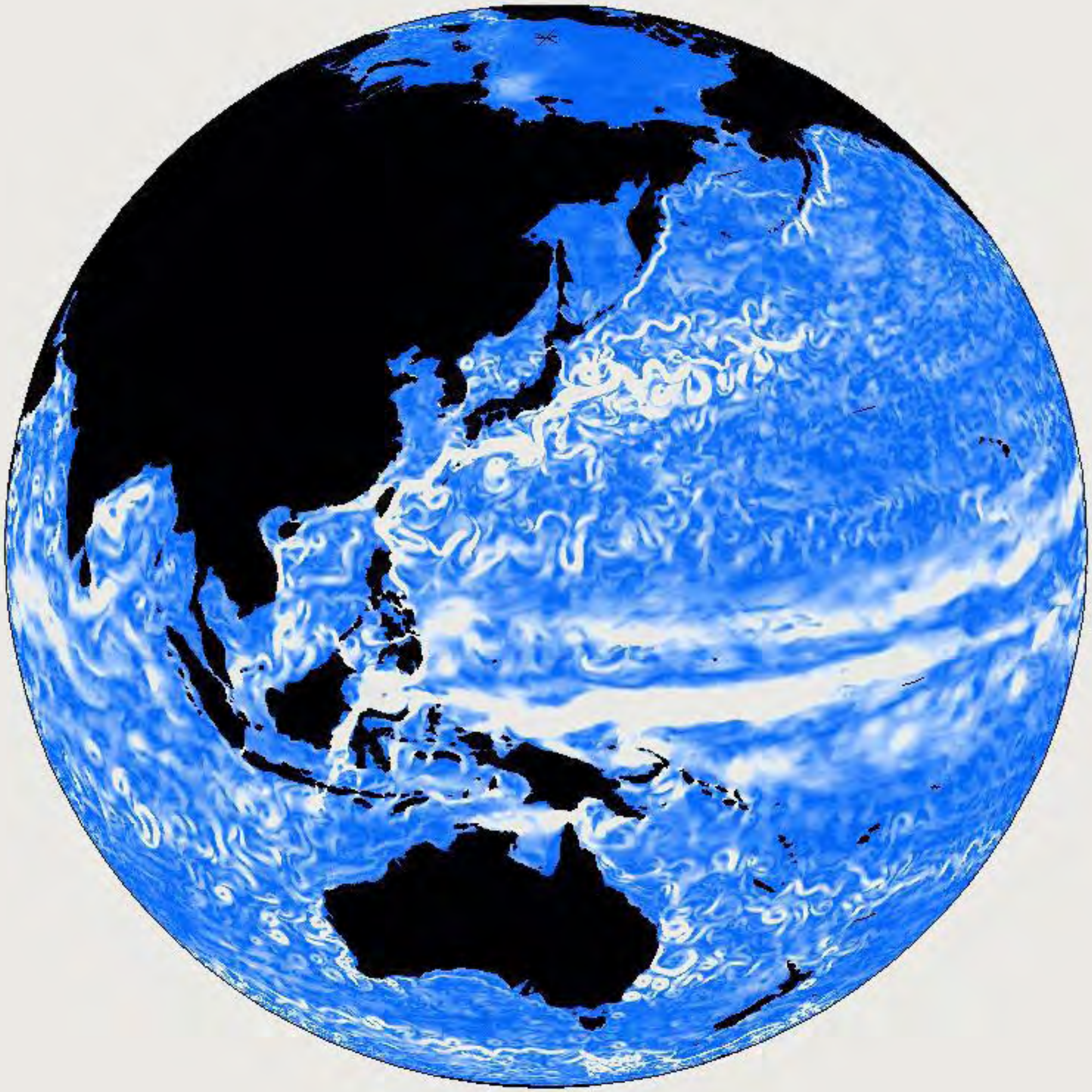


Vertical Temperature Distributions
Pacific
Atlantic
Indian
Pacific
Atlantic
With
wave-induce mixing
Without
wave-induce mixing
World Ocean Atlas
160°E
160°W
120°W
80°W
40°W
50°E
150°E
110°W
10°W
Along 35N transect in Aug.
Along 35S transect in Feb.

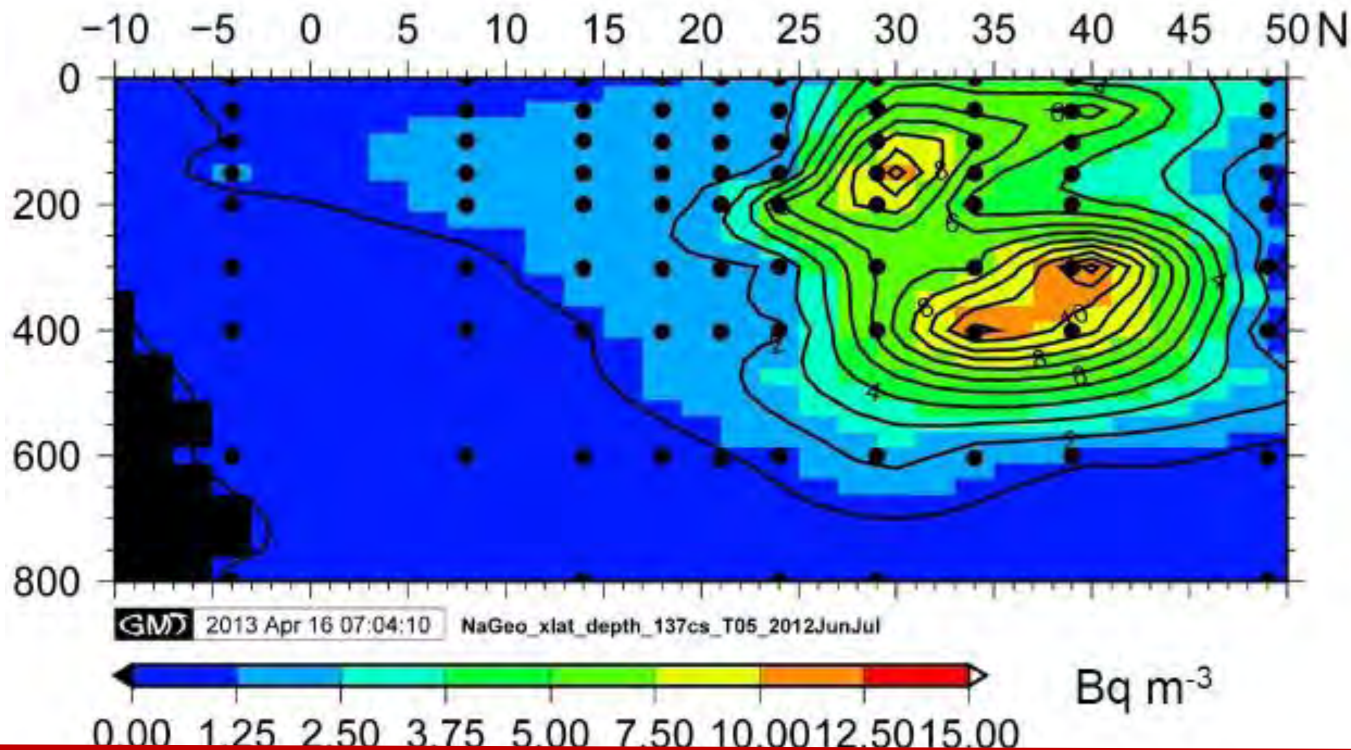
The two lines represent the whole upper ocean: Zonal (x-direction) and upper 100m (z-direction) averaged correlation coefficient (t).



Based on POM2008. Bleck, POM2008 without wave effects; Green: with wave breaking (and IW) suggested by Mellor (2004, JPO); Red: with Bv suggested by Qiao et al (2004)

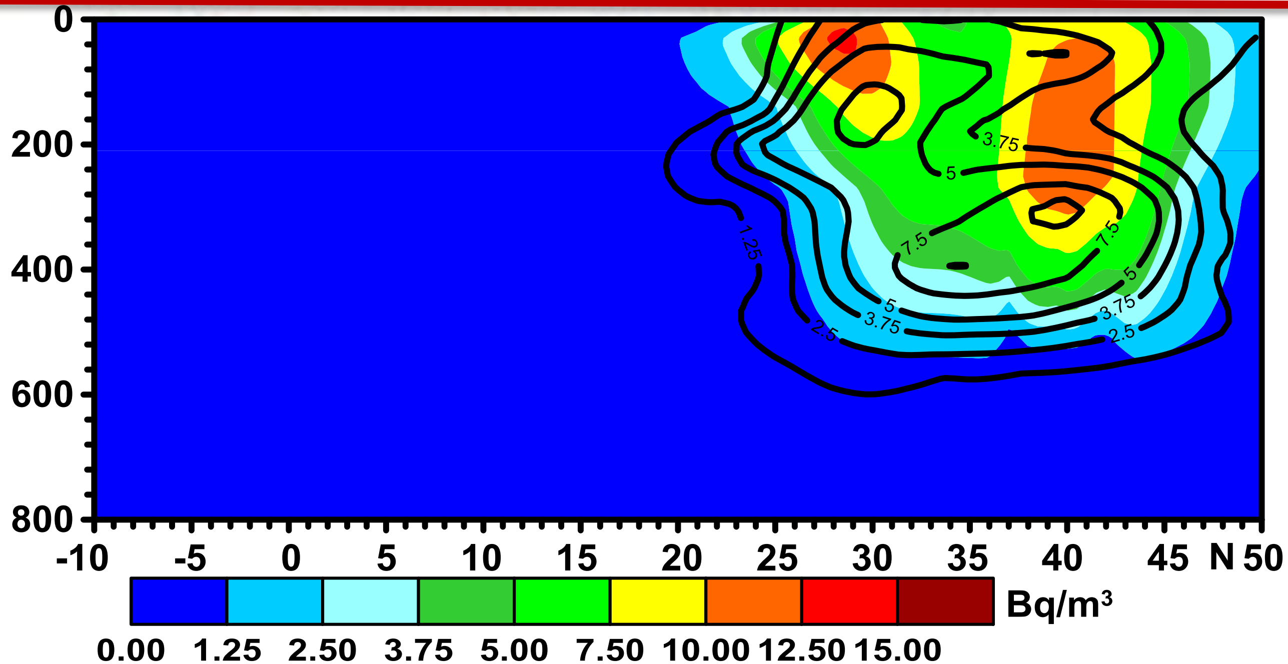


FIO wave-circulation coupled model with 0.1 X 0.1 resolution is set up

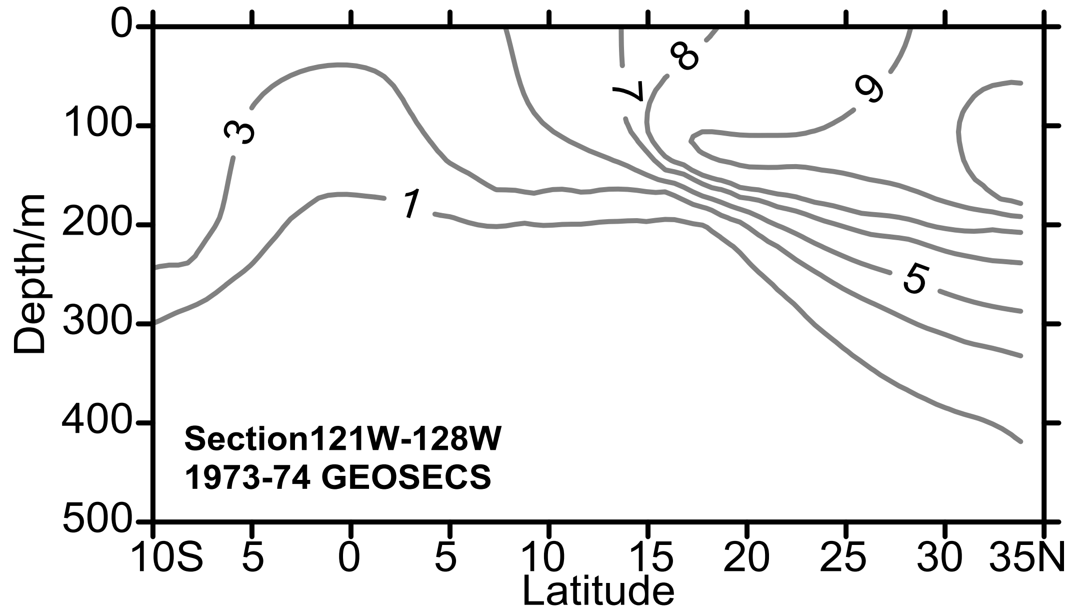


Aoyama et al Website of 2013

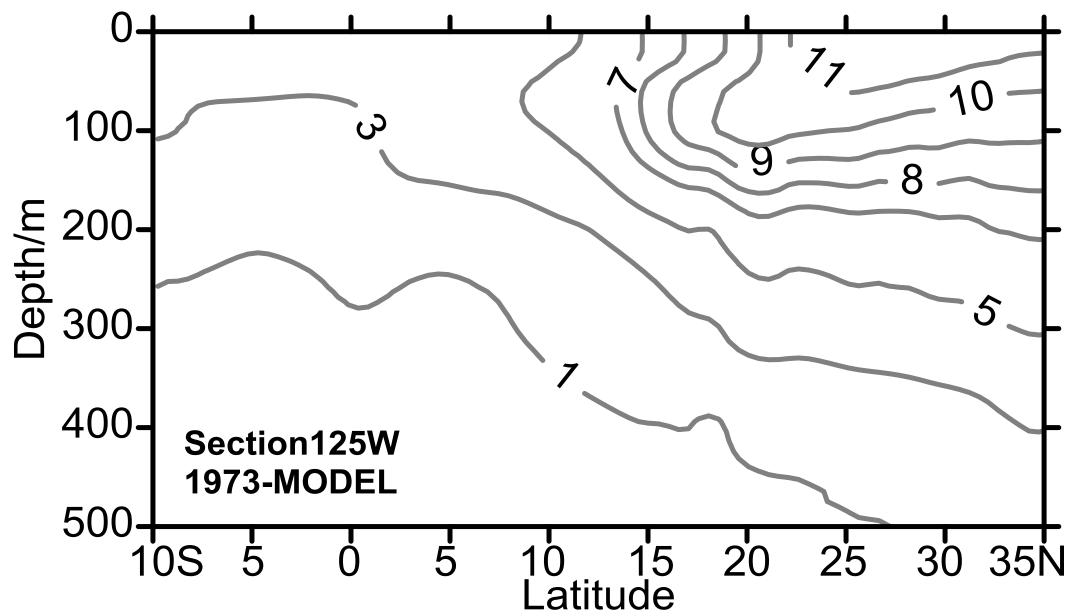
165E section Observation during June and July, 2012



Simulation for the same period



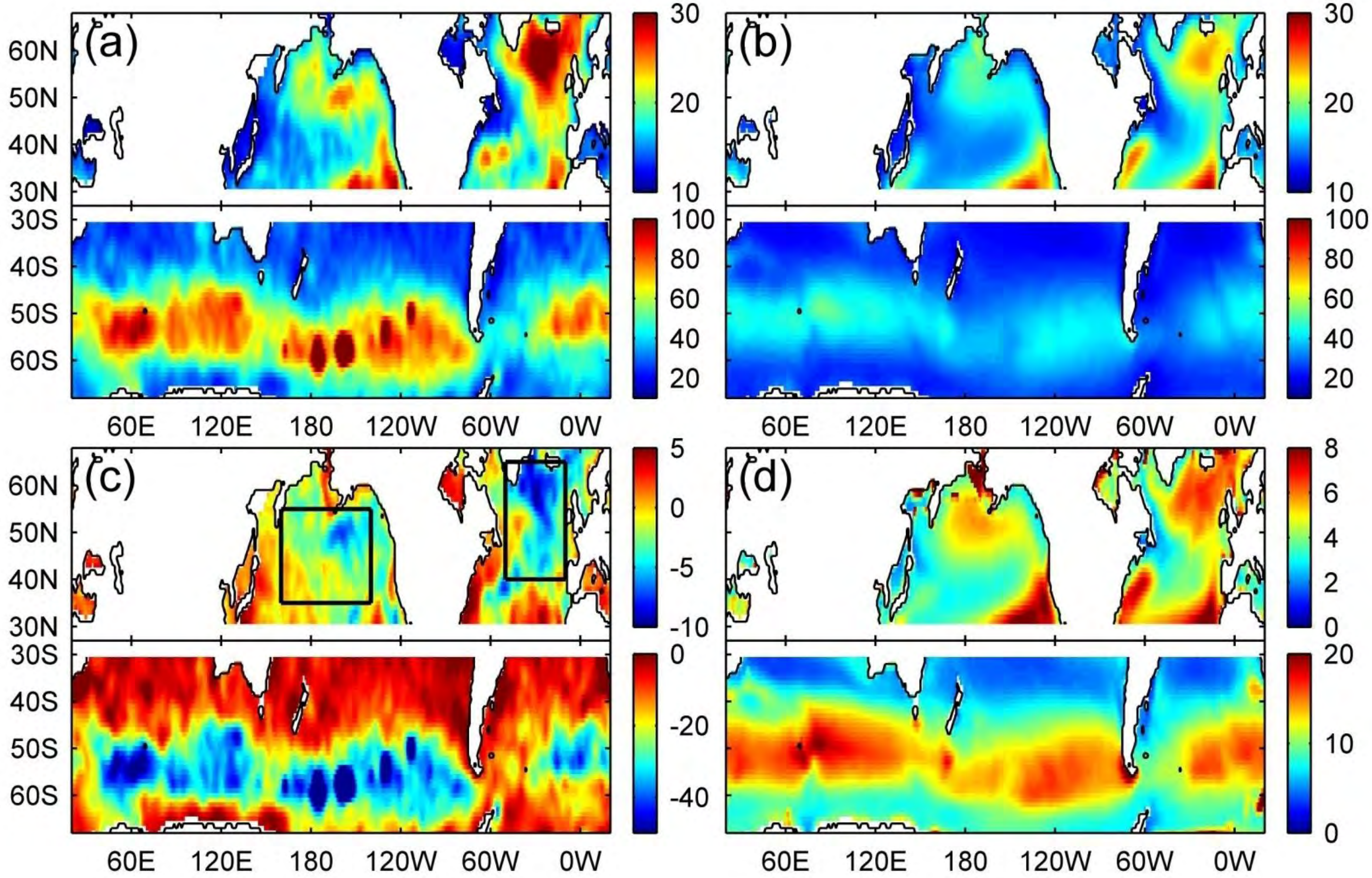
Observation during 1973-74



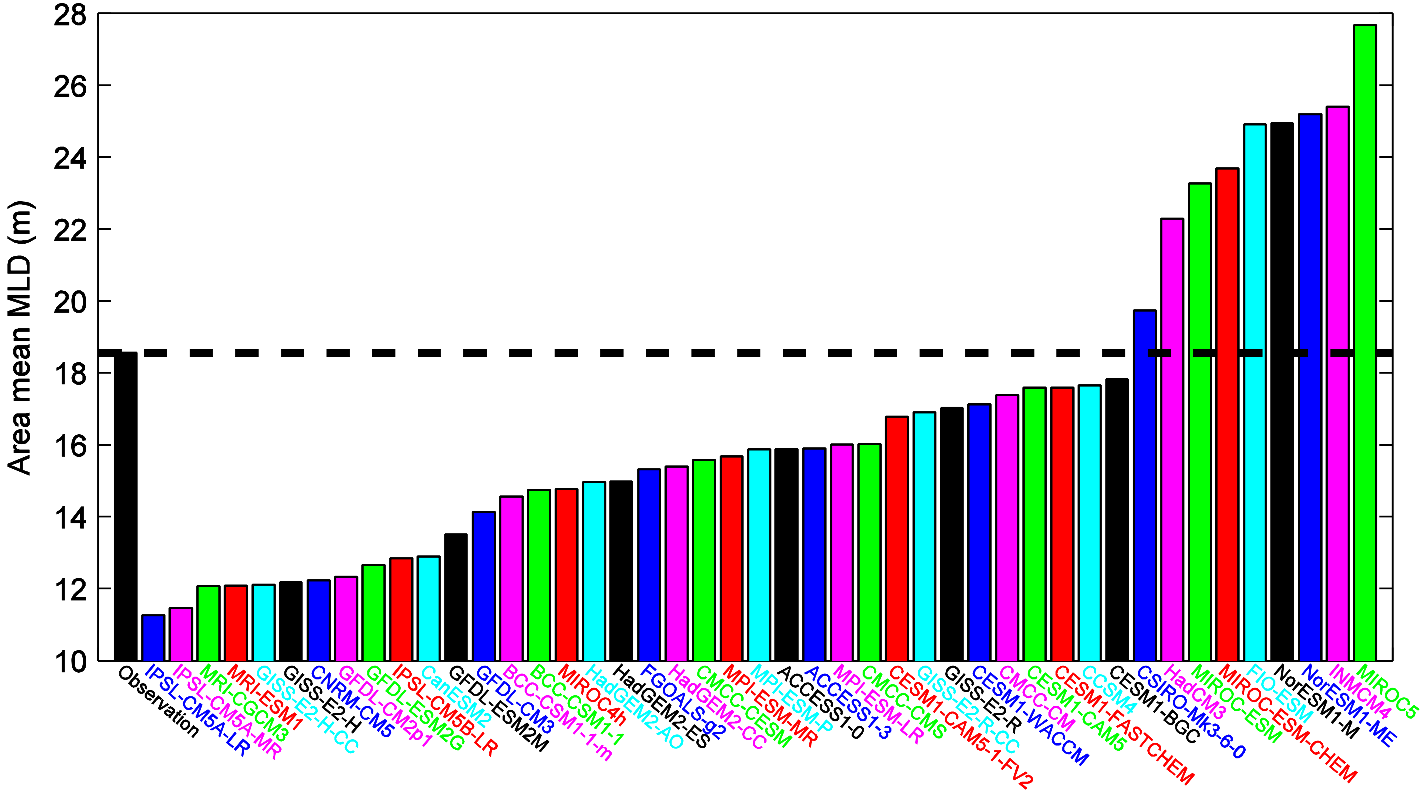
Simulation of 137Cs
1950-2010

Challenge 2

(2) Climate Models: The ML is too shallow in high latitudes; Tropical bias for all CGCMs.

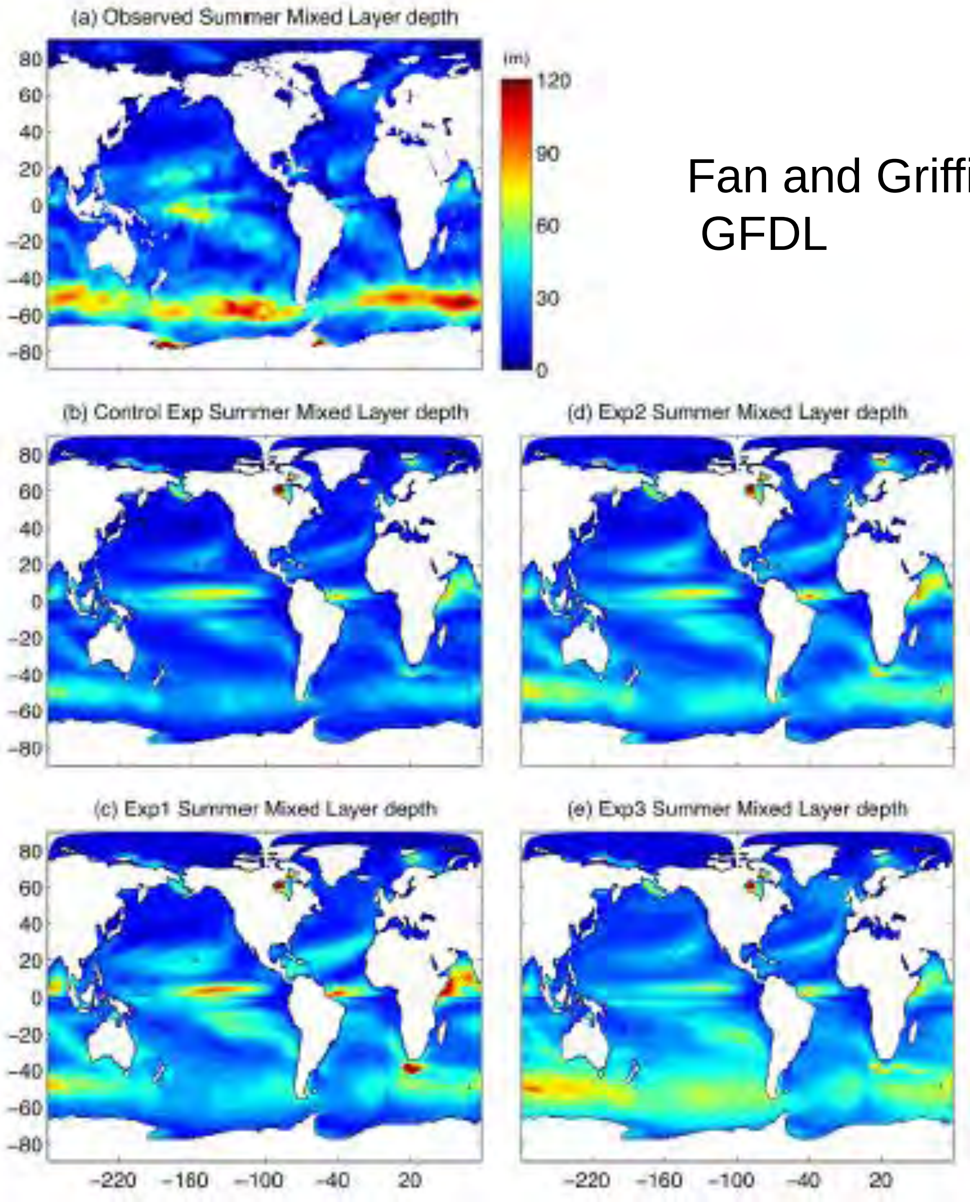


Multi-model ensemble summer MLD compared with observations (Jul-Sep and Jan-Mar for the Northern and Southern hemispheres, respectively). (a) Observations , (b) mean of the 43 models (excluding NorESM1-M and NorESM1-ME), (c) multi-model ensemble minus observations, and (d) uncertainties represented by multi-model standard deviation.



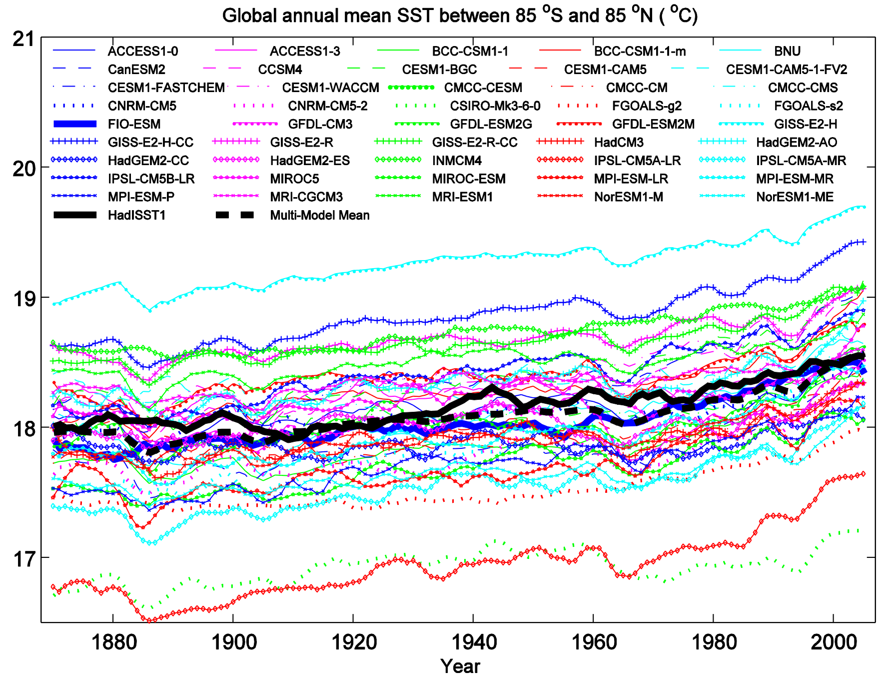
Area-averaged MLD (in m) in the central North Pacific Ocean (35ºN-55ºN, and 160ºE-140ºW) during the boreal summer from the 45 CMIP5 models and the observation.

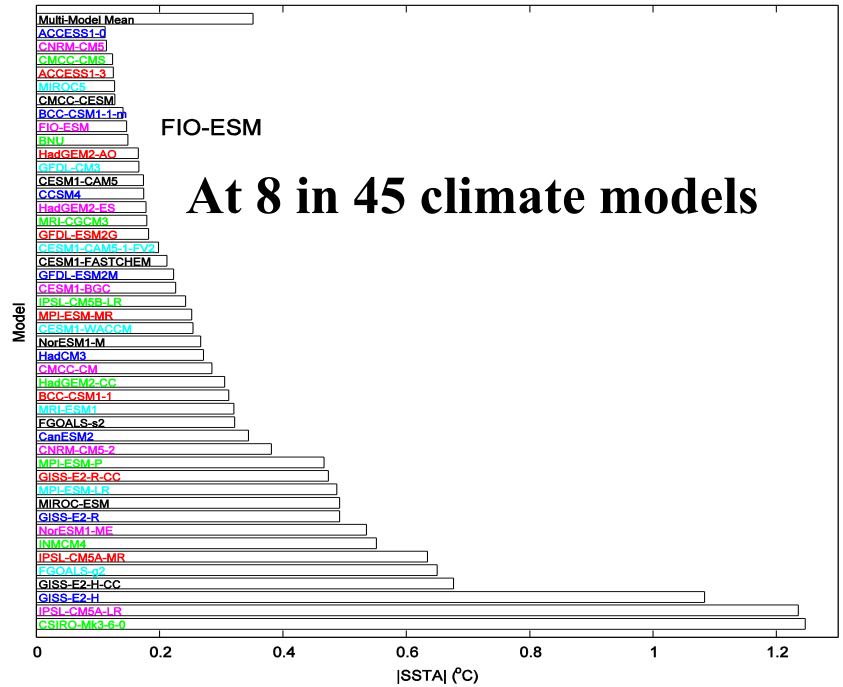
Huang and Qiao, 2014, JGR



Fan and Griffies, 2014, JC
GFDL

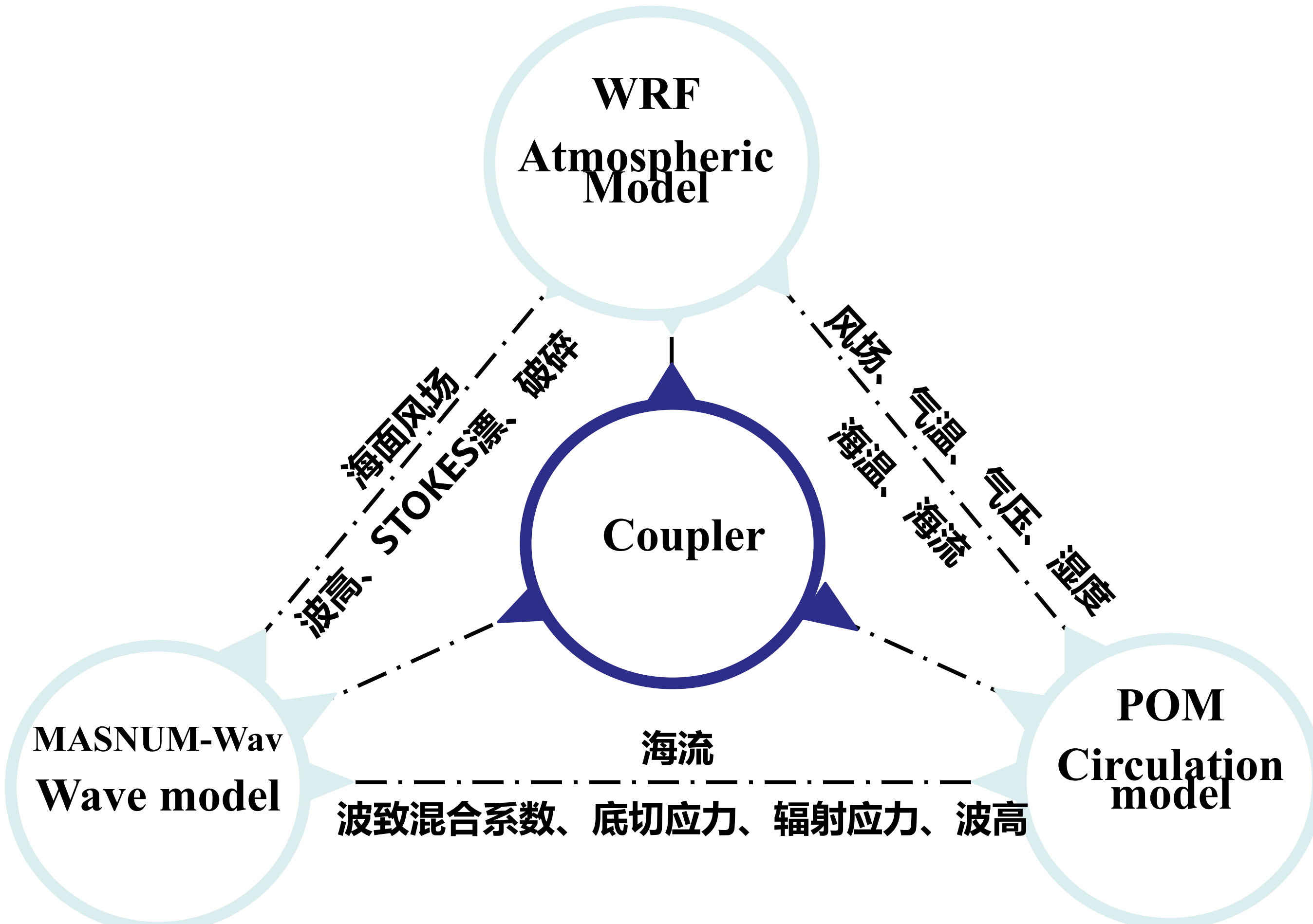
FIO-ESM climate model took part in CMIP5





Qiao, F., Z. Song, Y. Bao, Y. Song, Q. Shu, C. Huang and W. Zhao, *JGR*, 2013
Song, Z., F. Qiao, and Y. Song, *JGR*, 2012
Song Yajuan, Fangli Qiao and Zhenya Song, *JAS*, 2012
Song Zhenya, Qiao Fangli, and Wang Chunzai, *Science China Erath Sciences*, 2011

Regional climate model with surface wave is developing which can be used for downscaling in PICES area, north of 30N in the Pacific.



We would like to share the experience on improving forecasting ability of ocean climate within PICES scientific community.

4. Summary

(1) China will pay more and more attention on marine ecosystem and marine environment in the following 10 years. A series of key research projects closely realted with FUTURE are ongoing or will be arranged.

(2) China will pay special attention on the improvement of ocean and climate forecasting ability. Two projects from NSF and SOA were approved recently, which can support directly FUTURE of PICES.


Thanks for your attentio