The Macroalgae Blooms in Yellow Sea

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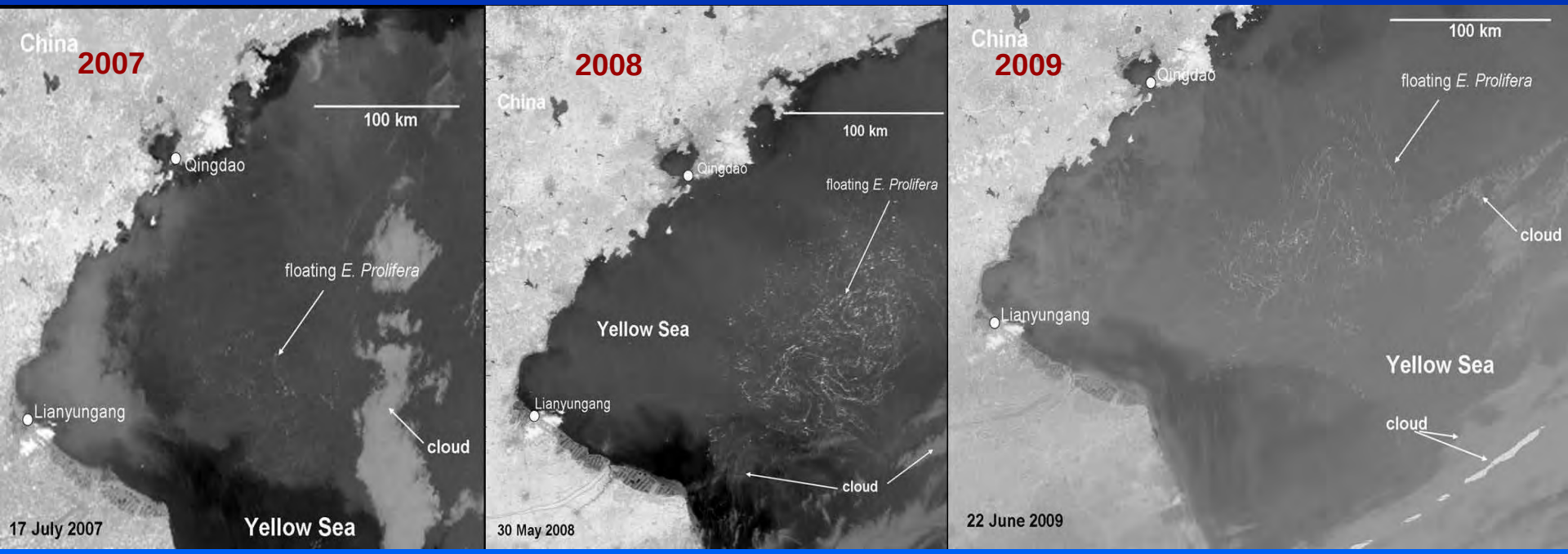
Macro algae bloom in coastal water of the world

Large Scale Green tide in Coast water of Qingdao in 2008

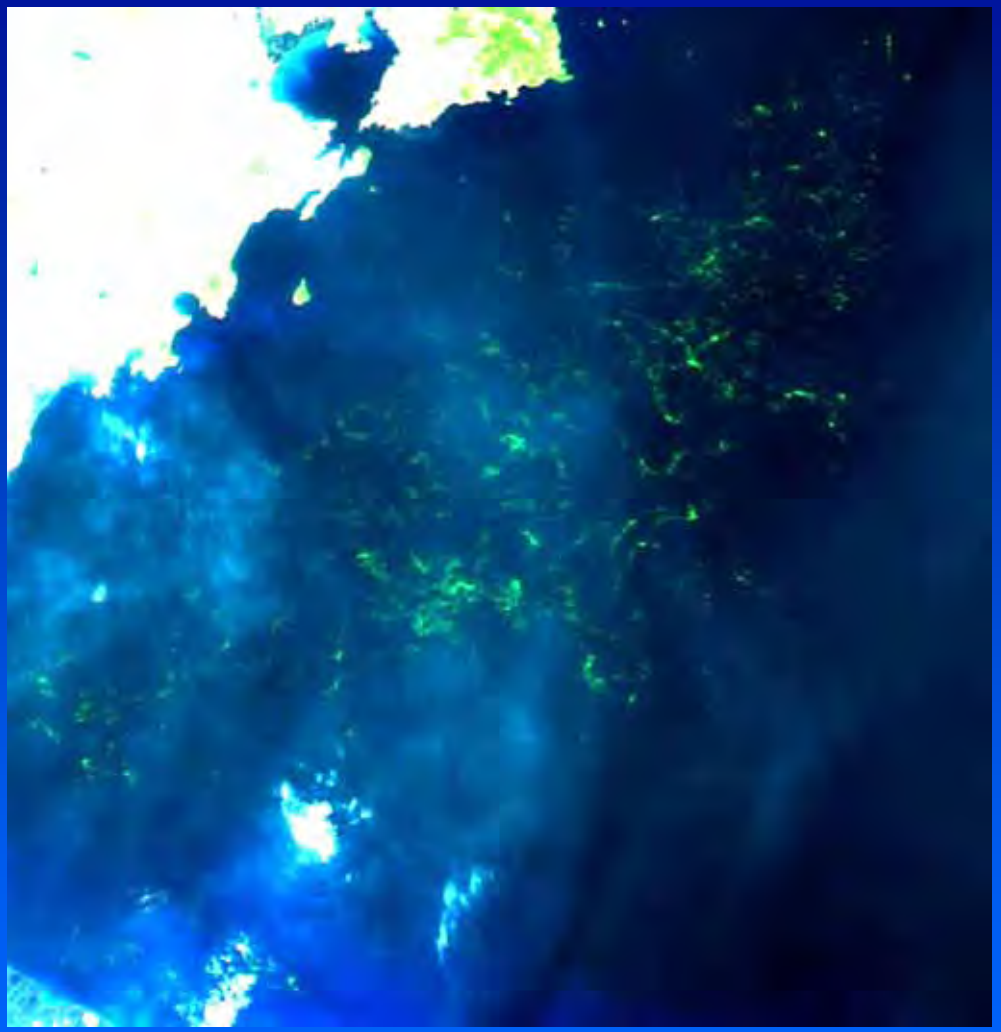
10,000 people cleaned up 80,000 tonnes

The Olympic Sailing Game was successfully held

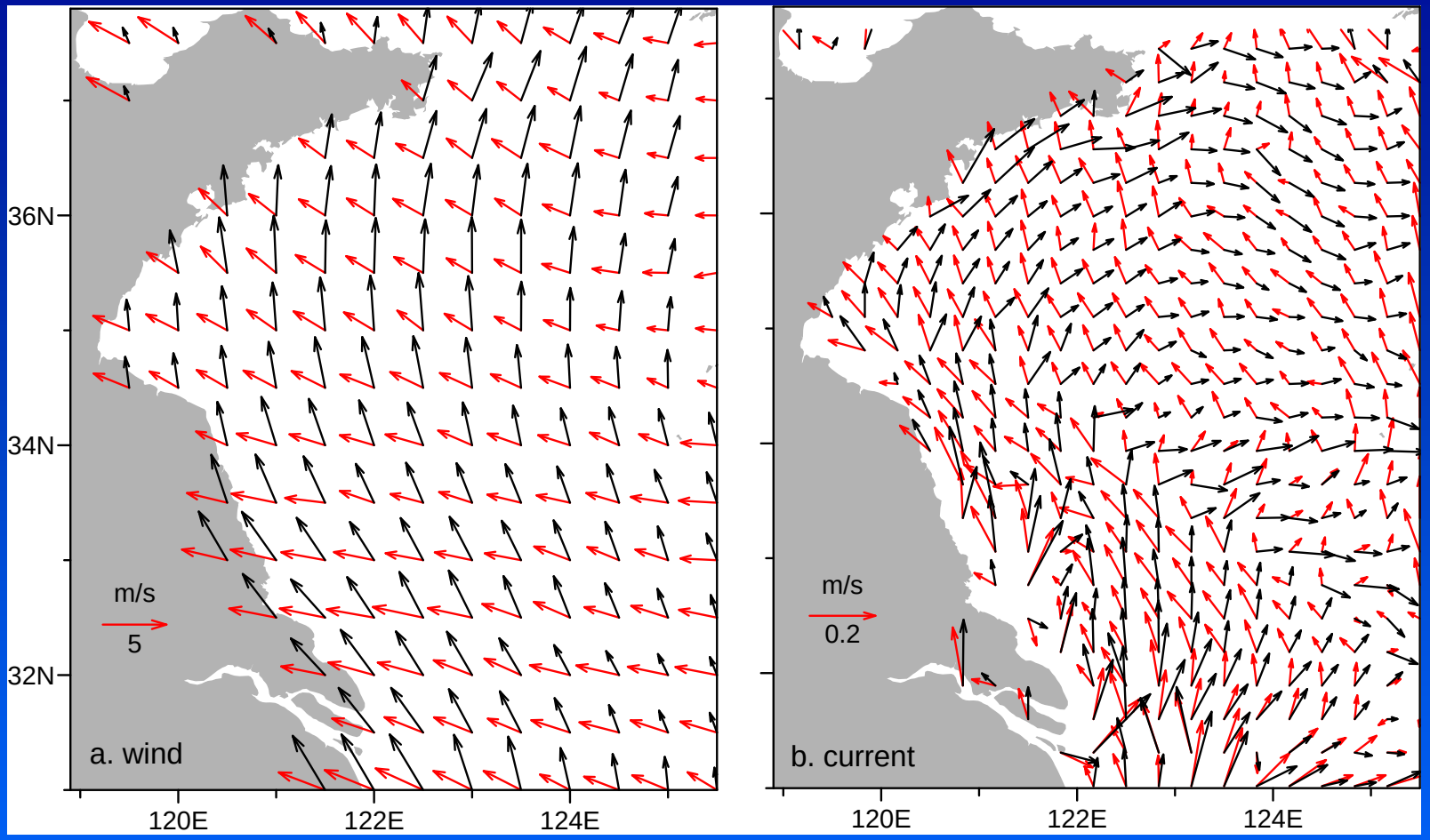
Satellite images of green tide



From Dongyan Liu



From **NASA MODIS June 19, 2011**

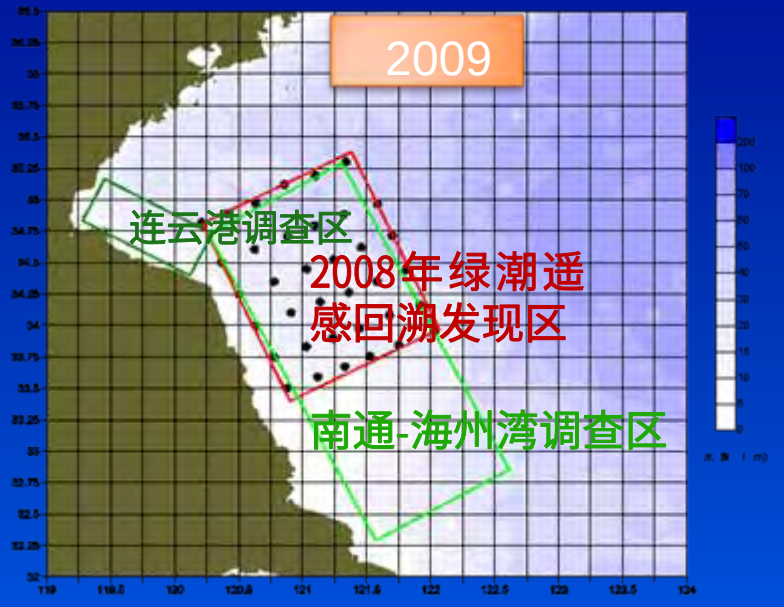


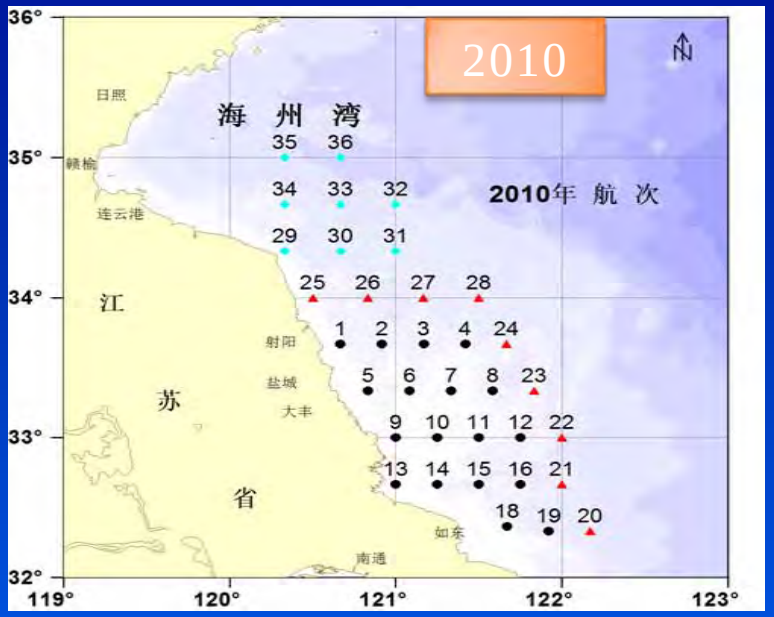
Comparison of monthly mean wind and simulated surface current in June 2008 and 2009

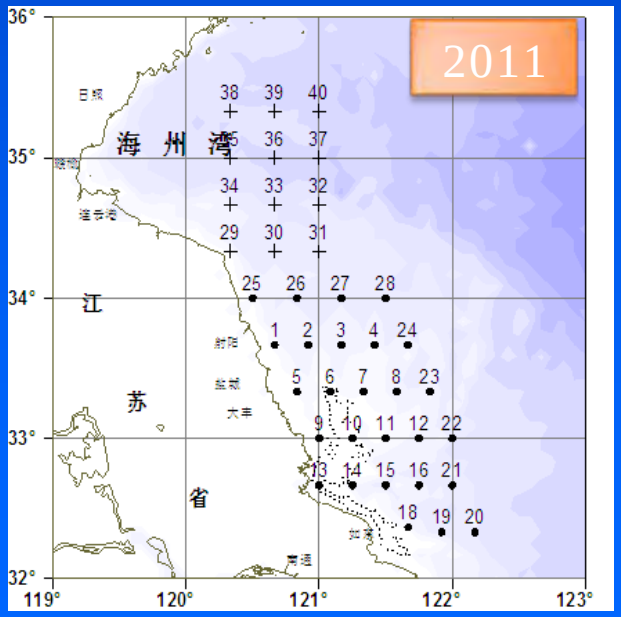
2008 2009

From Fangli Qiao **2010,GRL**

Field survey area

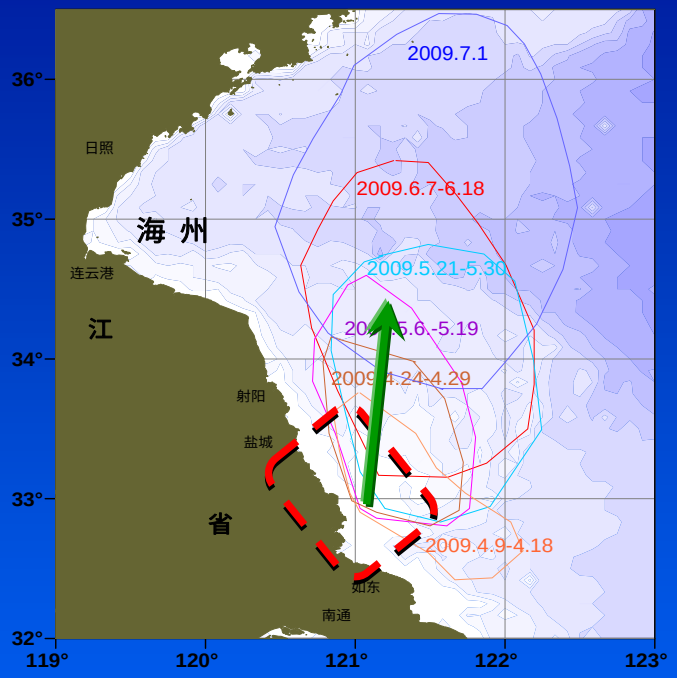




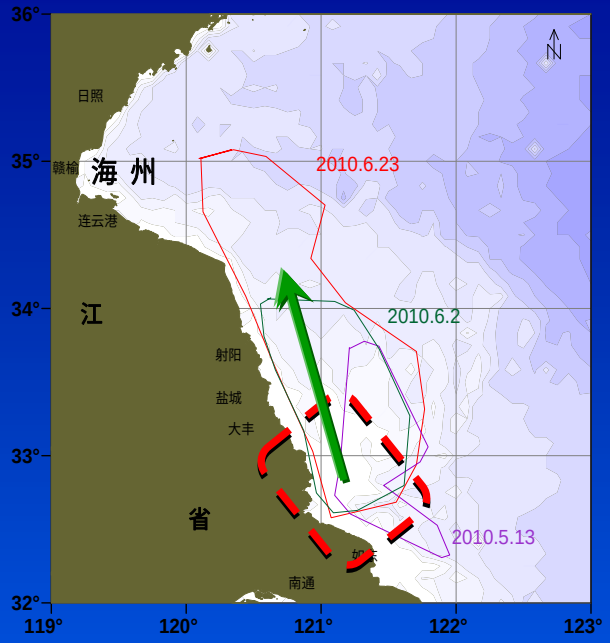


Every year the survey started in April in coastal waters of South-west Yellow Sea. When the floating algae appeared, the survey area was larger and moved towards north.

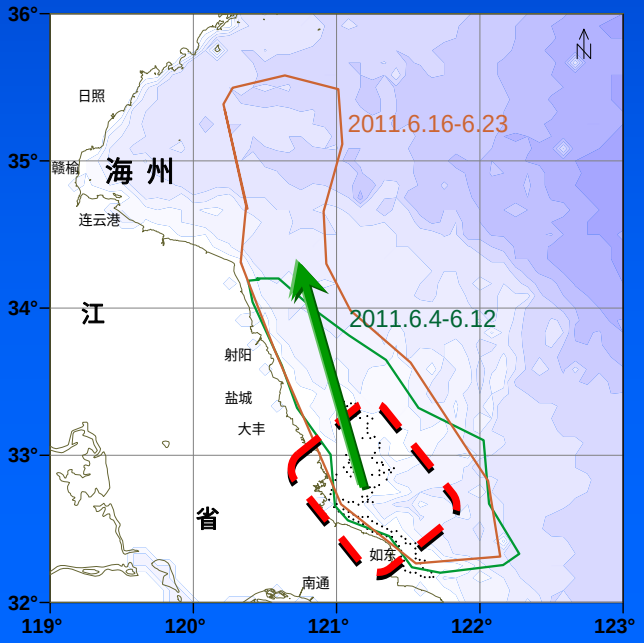
The development of green tide from field survey



2009



2010



2011

The floating green algae was initiated in coastal water near large scale *Porphyra* culture of South west Yellow Sea .

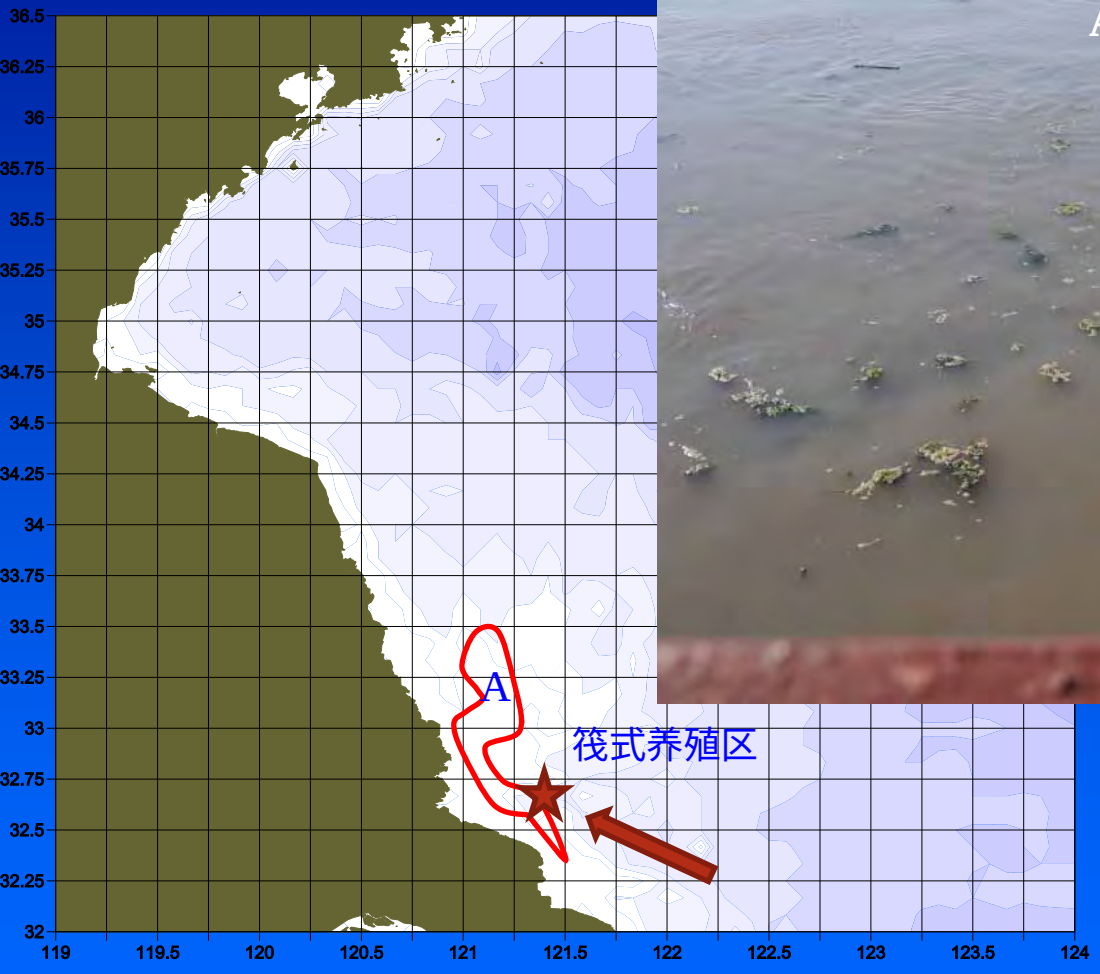
The date of green tide first time being observed ：

April 17, 2009

May 4, 2010

May 16, 2011

Initiative stage: The occurring of floating green algae

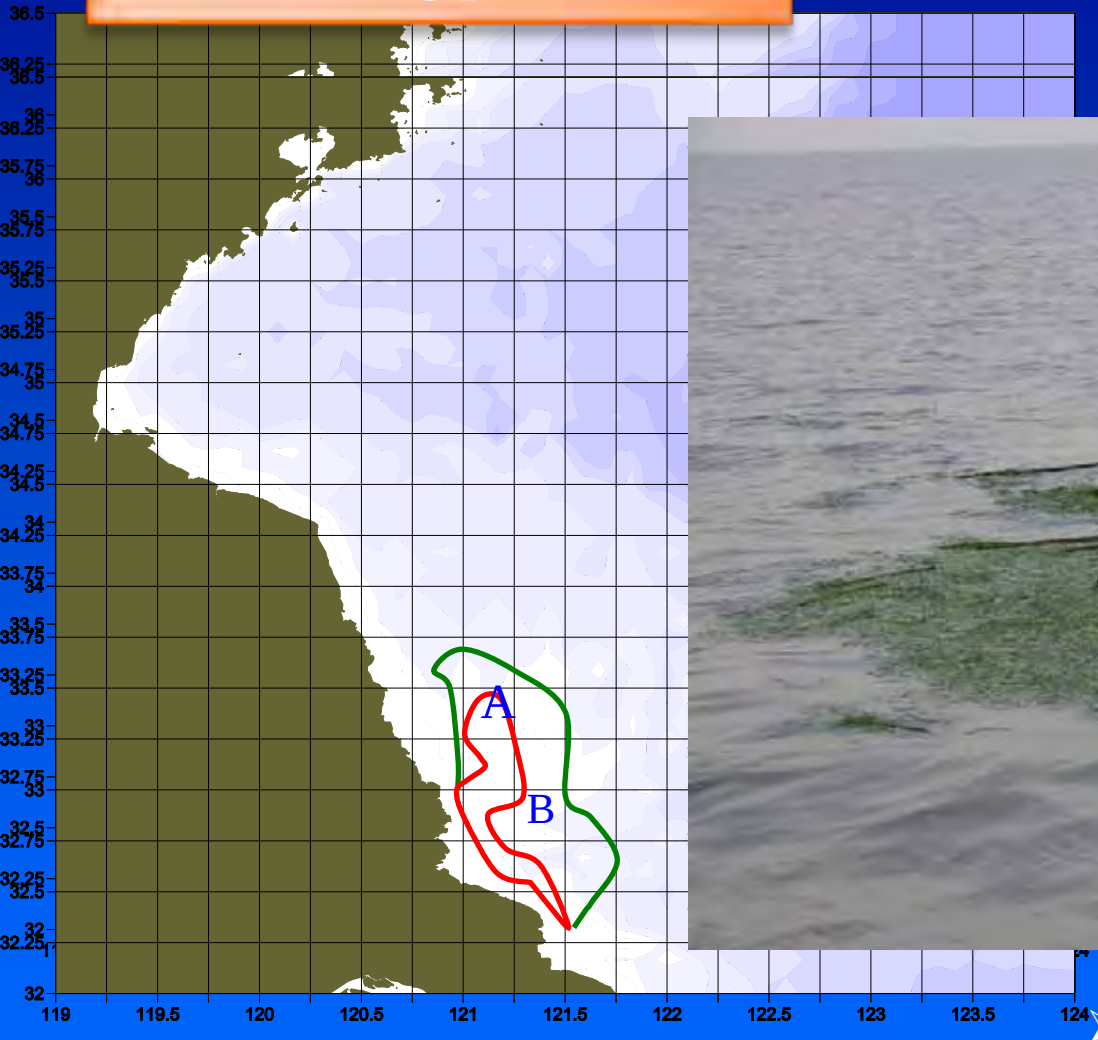


- Floating green algae near the Porphara Culture ：
- The estimated biomass 1.35t
- The coverage area .002 km^2.

★ Site of floating algae being found for first time（April 17, 2009）

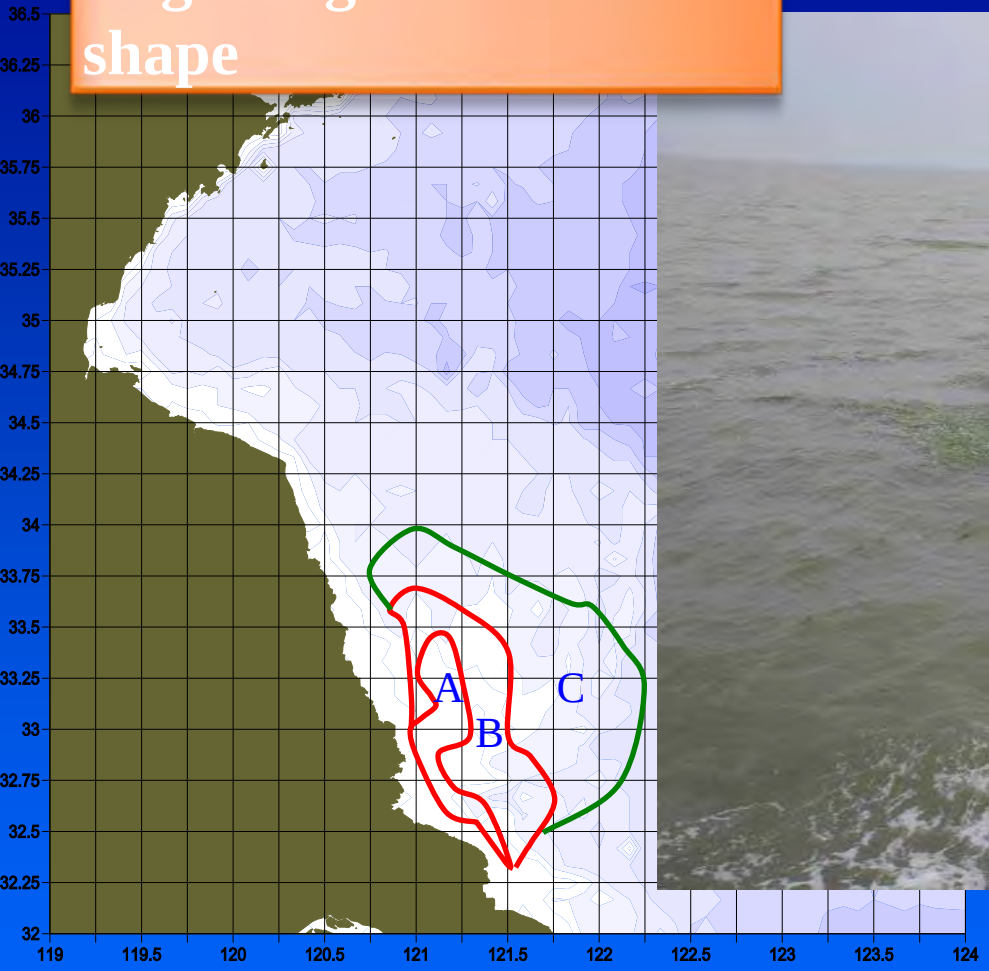
Early development stage: small floating patches

April. 26, 2009



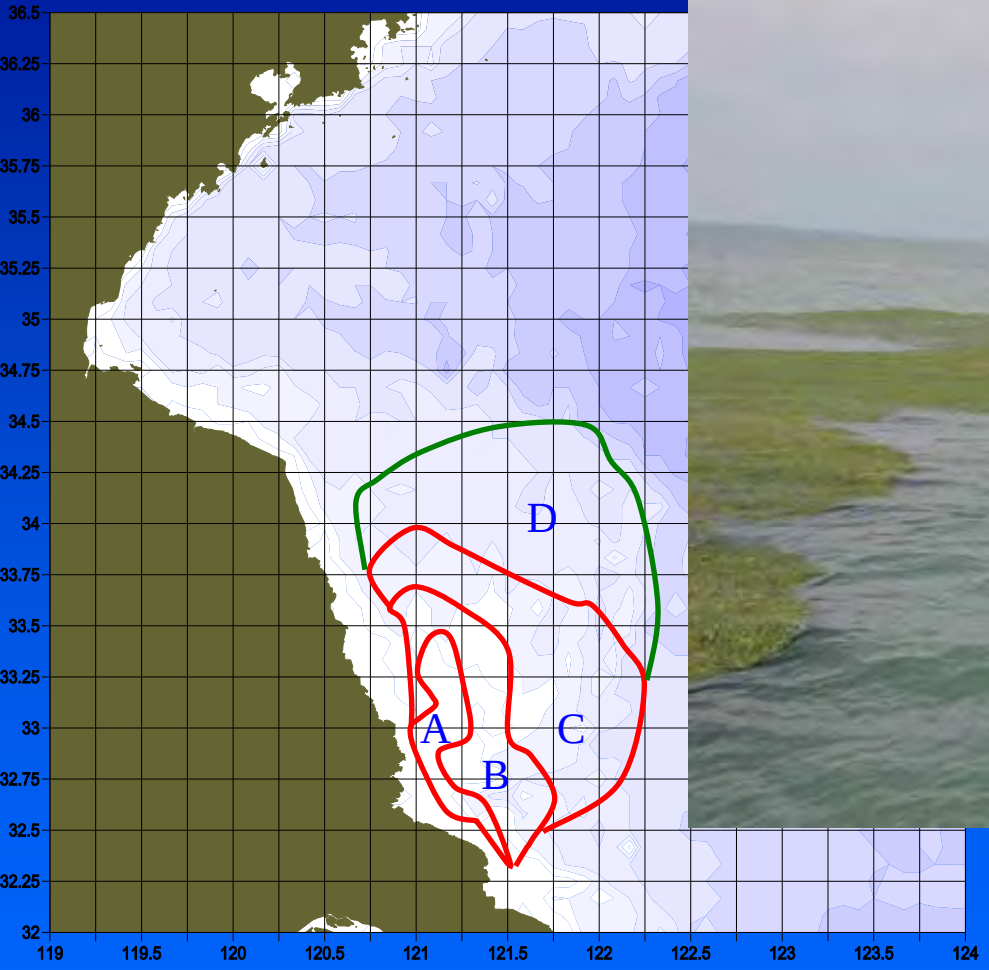
- the floating algae begin to grow
- the estimated biomass 63 t
- The coverage area .08 km^2.

Growth and aggregation stage : algae in belt shape



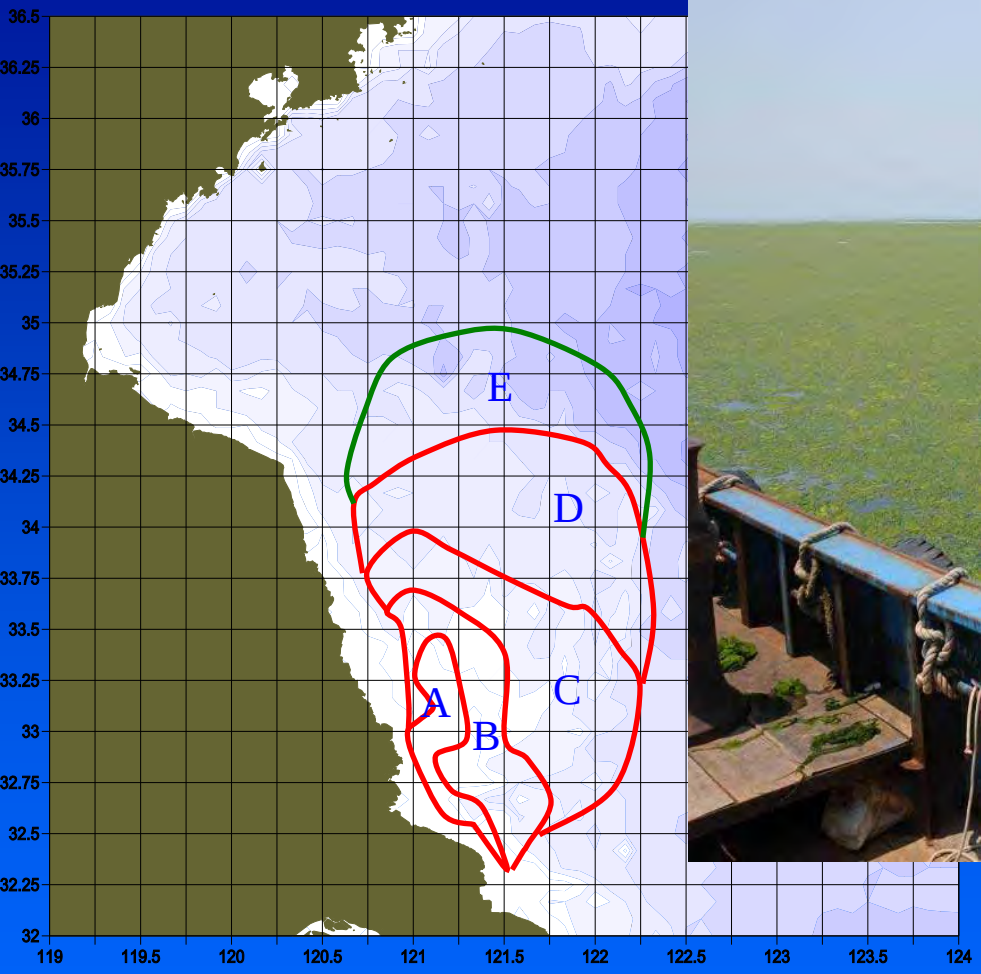
- algae in belt shape
- The estimated biomass 186 t ;
- The coverage area 0.25km².

Large belt stage



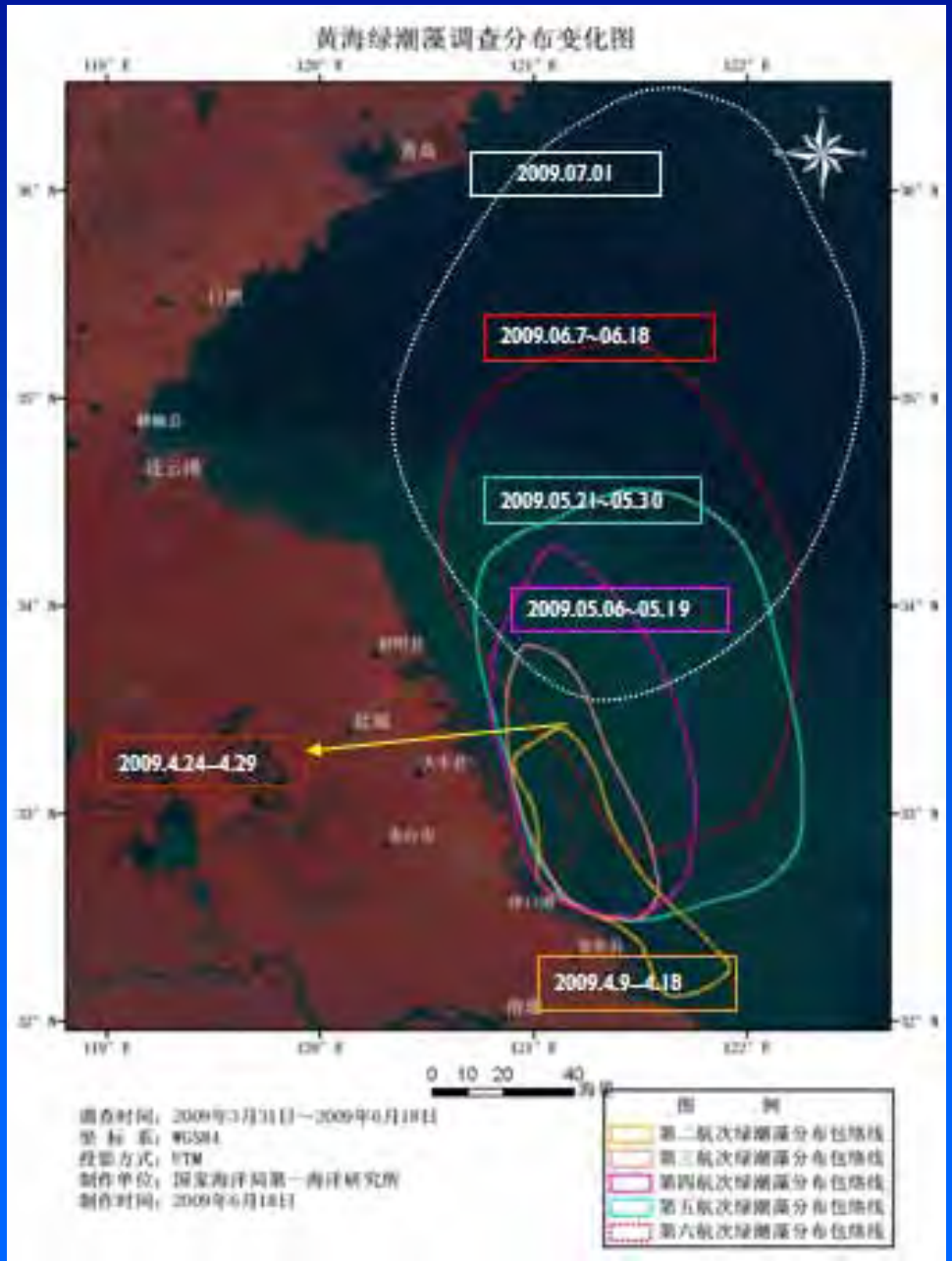
- The estimated biomass 118,000 t；
- The coverage area 150 km^2.

Large scale green tide Stage



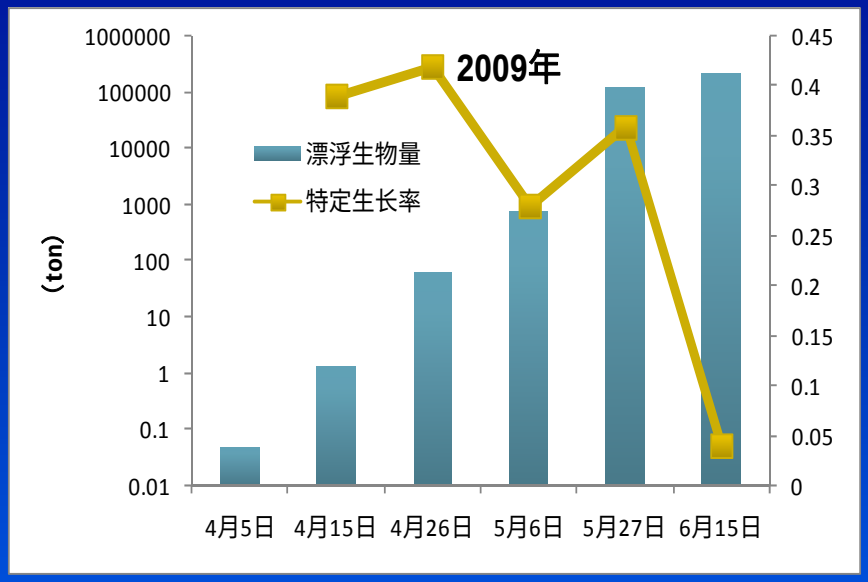
- Large scale, high biomass green algae；
- The estimated biomass 208 ,000 t；
- The coverage area 260km^2.

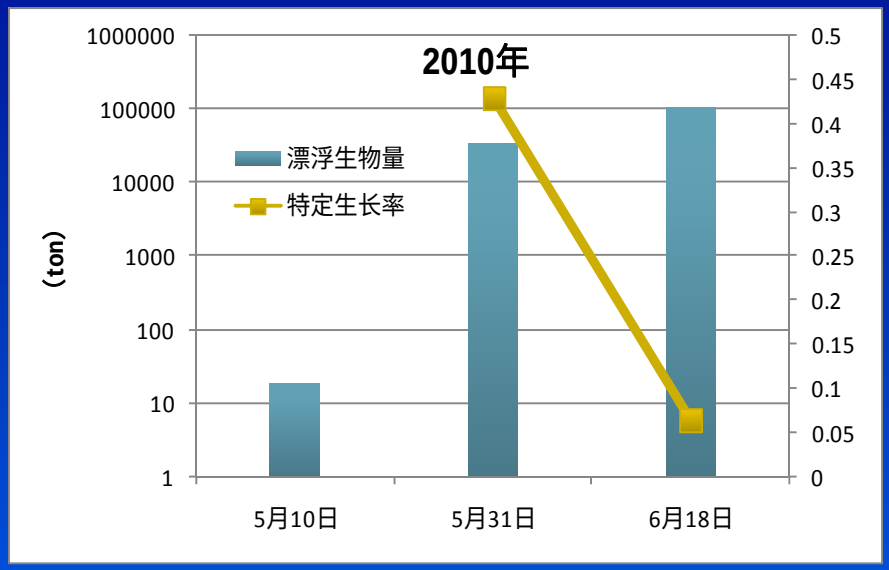
The development of floating algae(2009)

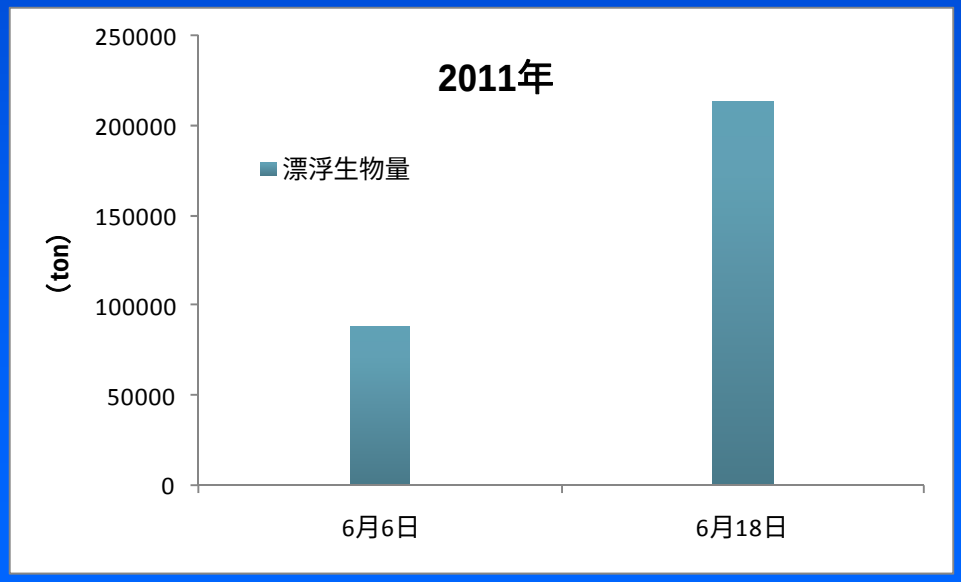


Max. Coverage：479 km^2
Max. distributed area：
37,247 km^2

The biomass and growth rate of floating green algae

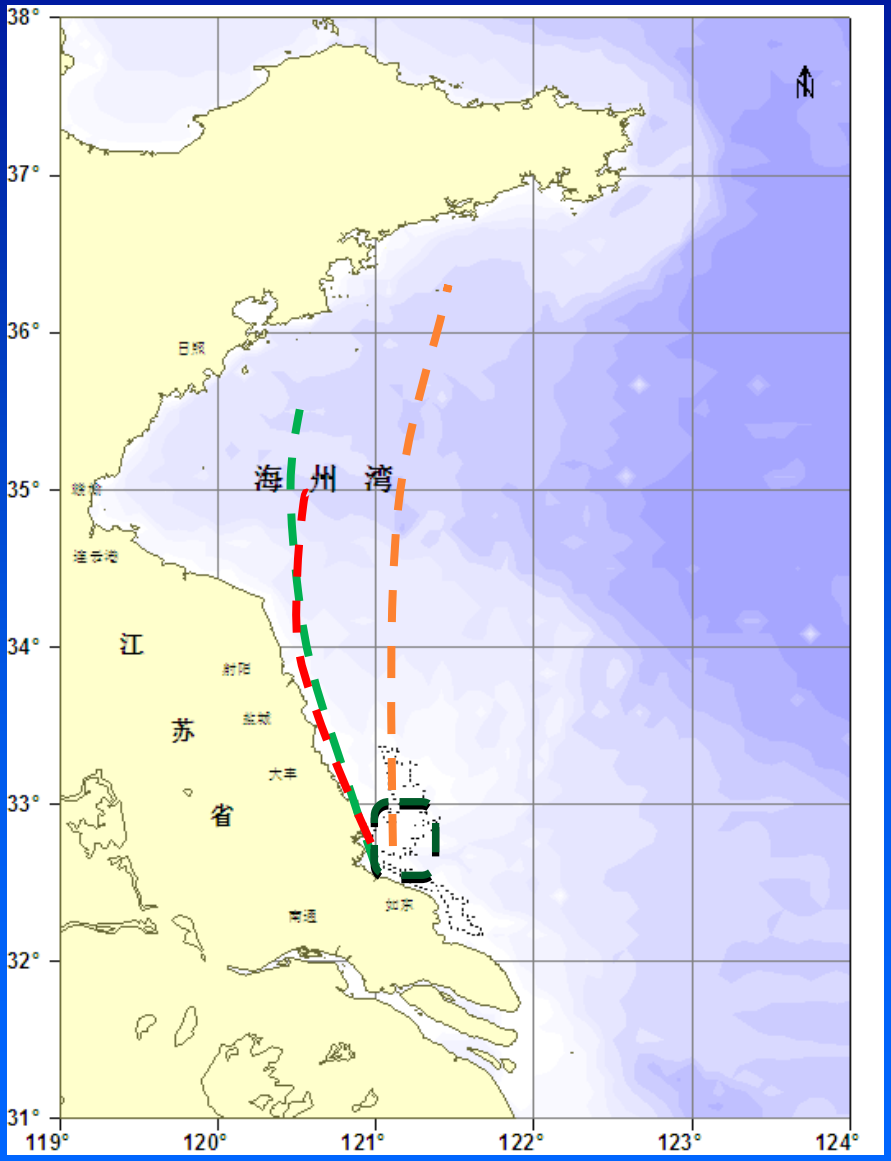






- **The growth rate of green algae in earlier stage is much faster than that in later stage**

The site of origin and moving route of green tide in Yellow Sea



In 2009—2011，the site , where floating green algae were firstly found , was almost the same. It is near Taiyang Island, outside of Xiaoyangkou Harbor. Then it was at the area of 32.25-33.50 ^{O}N，and 30 nautical miles off shore. It moves towards north and becomes larger, more aggregated and forms the large scale green tide. The temperature plays important role and nutrients provide necessary materials for the algae growth.

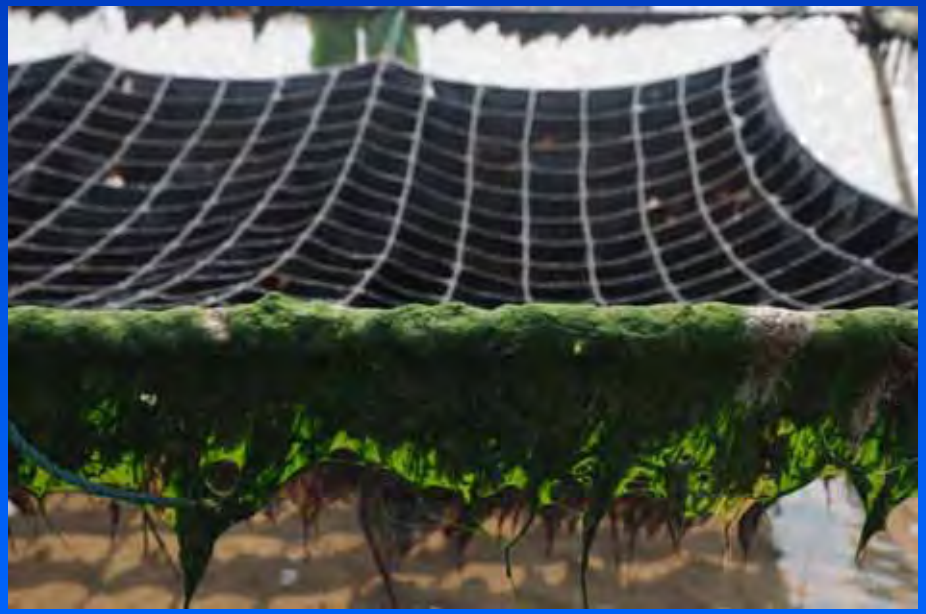
Moving route in 2009

Moving route in 2010

Moving route in 2011

The site ,where floating algae were firsrtly found

The variation of green algae on the pole and rope of *Porphyra* culture in coastal waters of Jiangsu Province

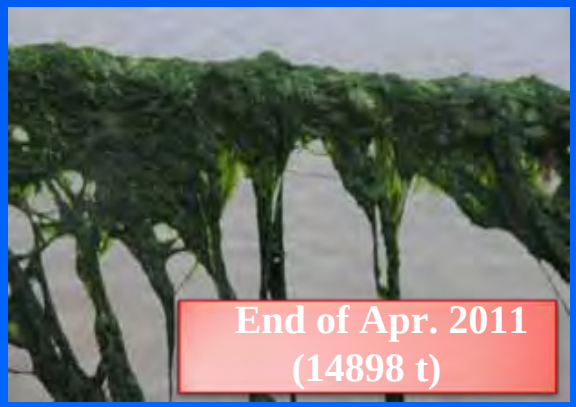


Habitat of *Ulva prolifera* along the coast of South Yellow Sea

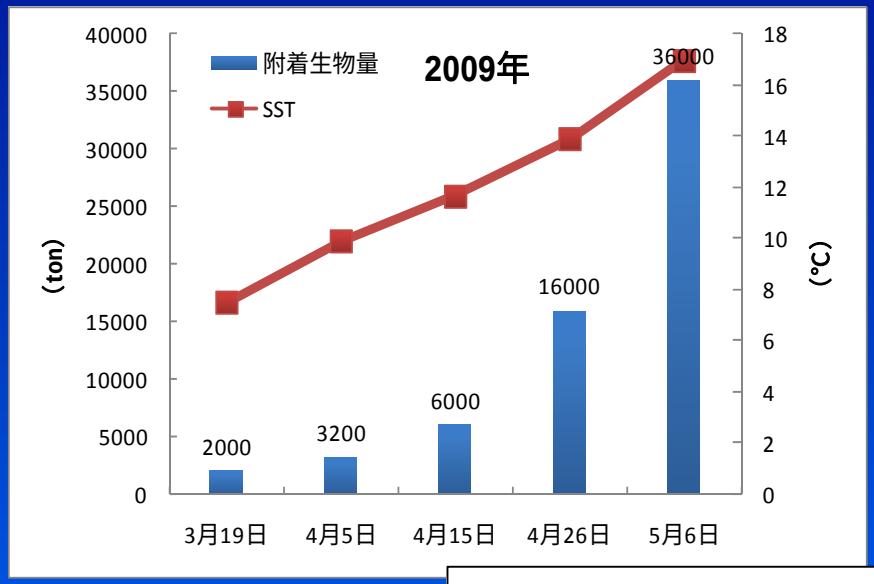
Habitat of green algae — Culture area of *Porphyra*

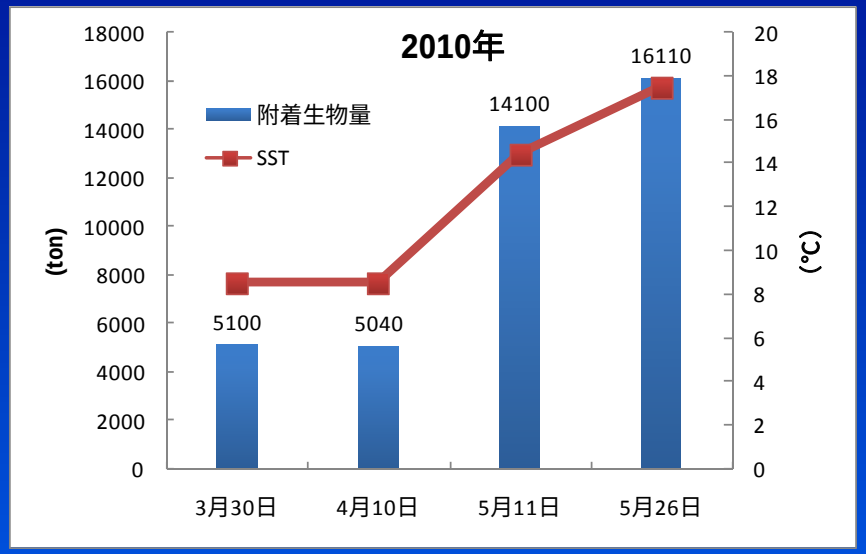
Rafts for *Porphyra* culture in intertidal zone

The variation of biomass of green algae from Oct. 2010 to April 2011 on the rafts

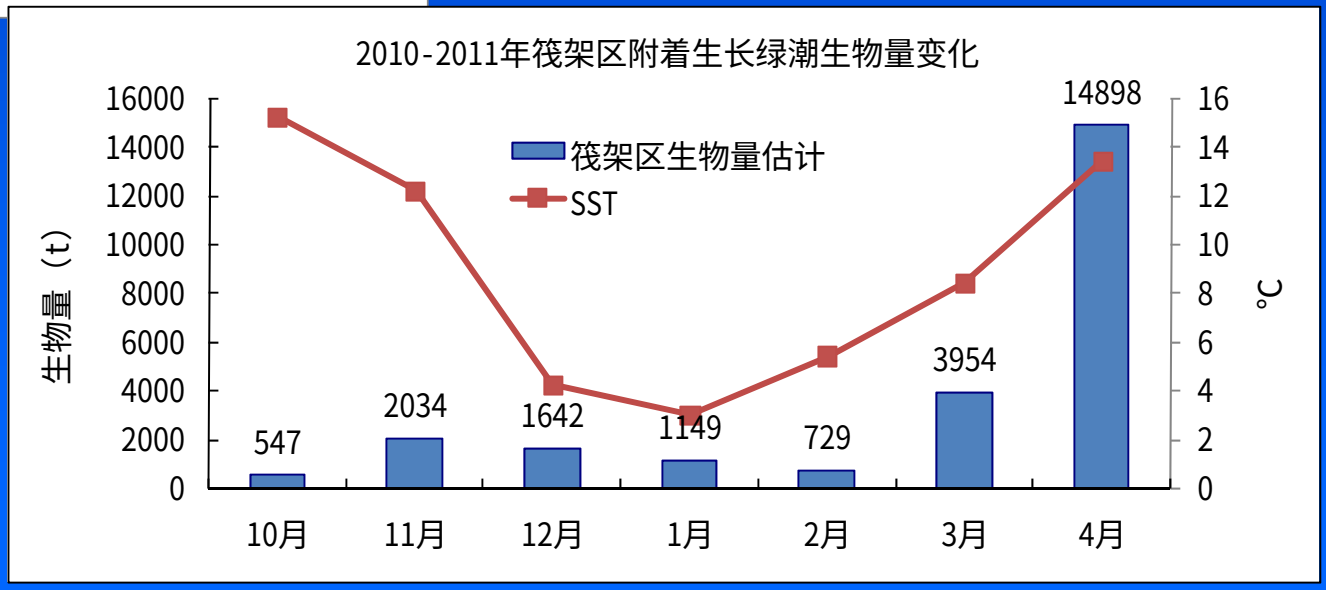


Variation of green algae on the rafts in 2009-2011





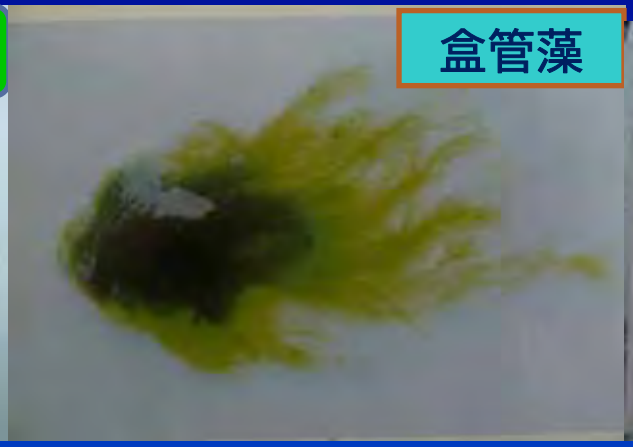
The variation of green algae coincided with the increase and decrease of temperature in 2009～2011



The species composition of green algae on the rafts of *Porphyra* culture

The species of green algae on the rafts include *Ulva* (*Enteromorpha*) *prolifera, Capsosiphon groenlandicus, Ulva intestinalis* , *Ulva linza, Ulva clathrata* , *Ulva compressa* etc.

Ulva (Enteromorpha) prolifera

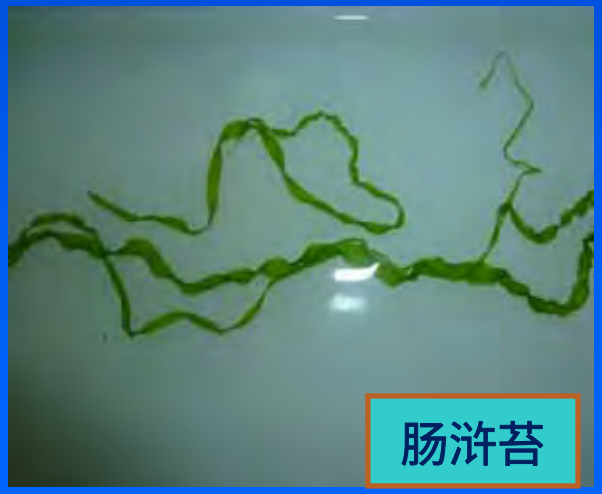


Capsosiphon groenlandicus

U. linza

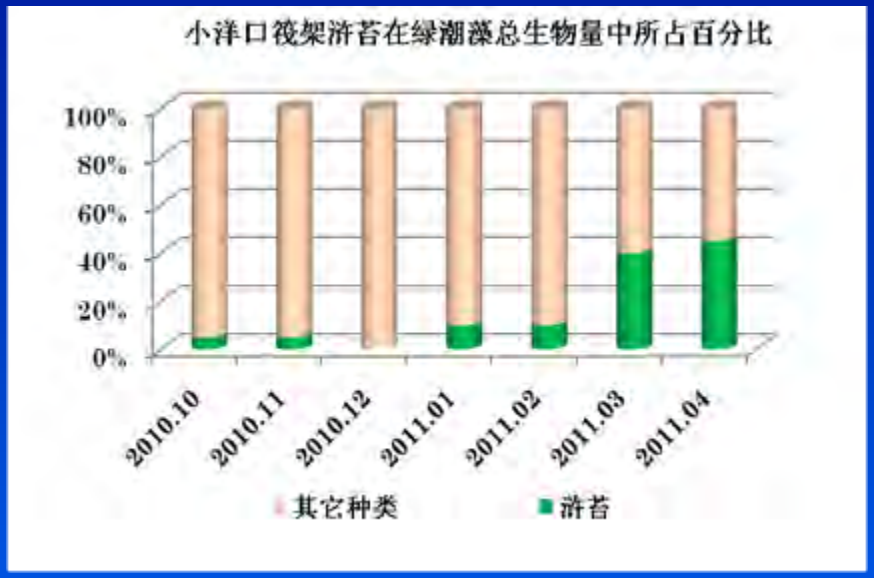
U. compressa

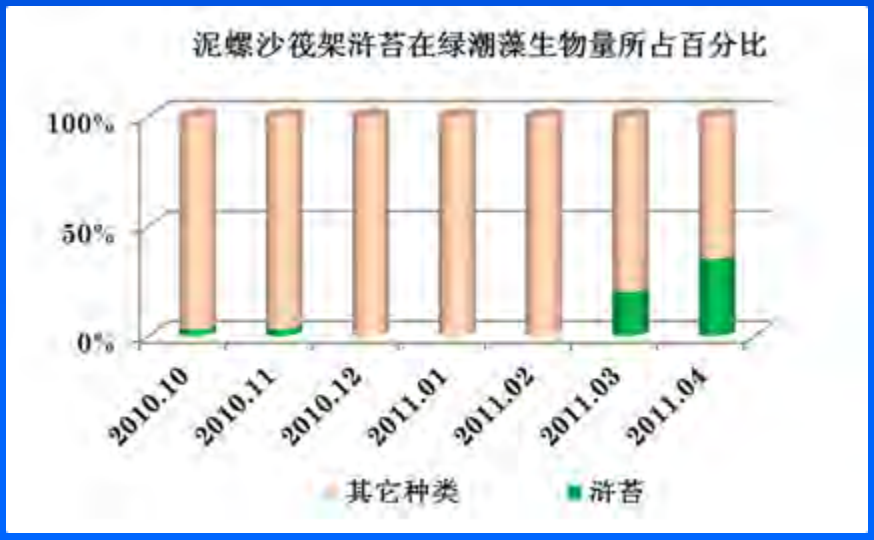
U. clathrata



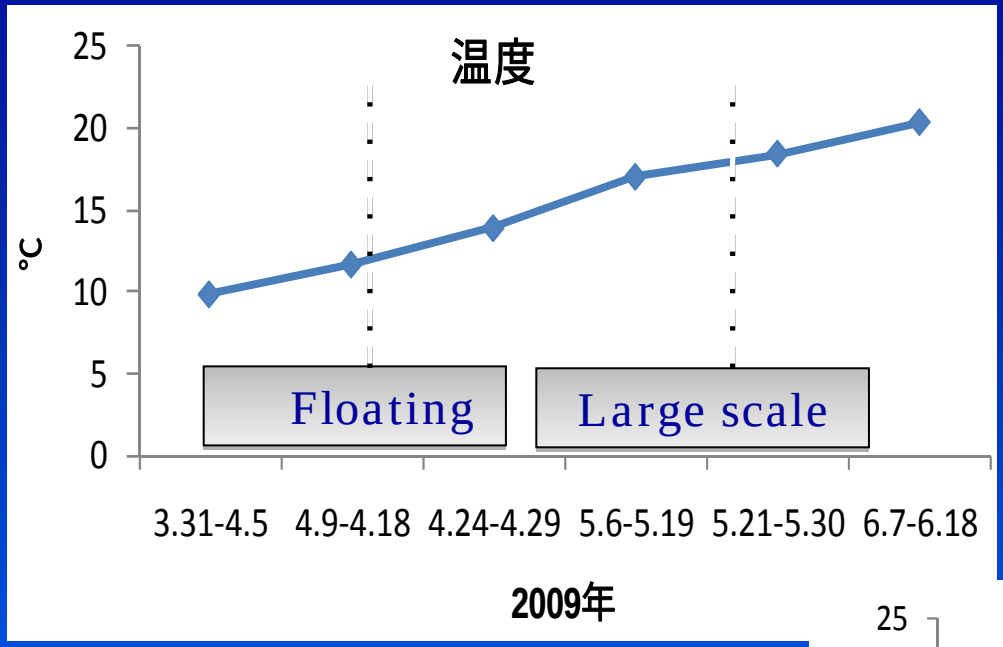
U. intestinalis

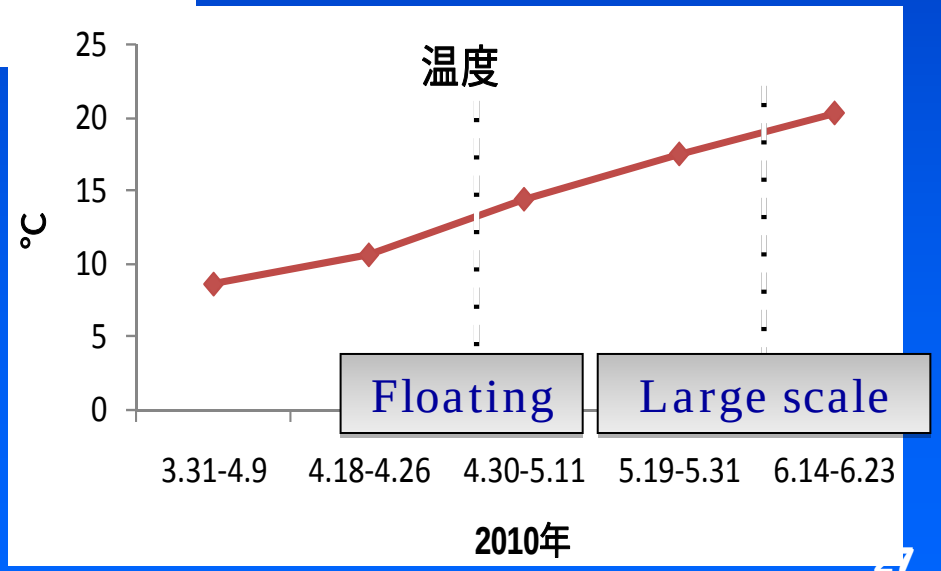
The proportion of species composition





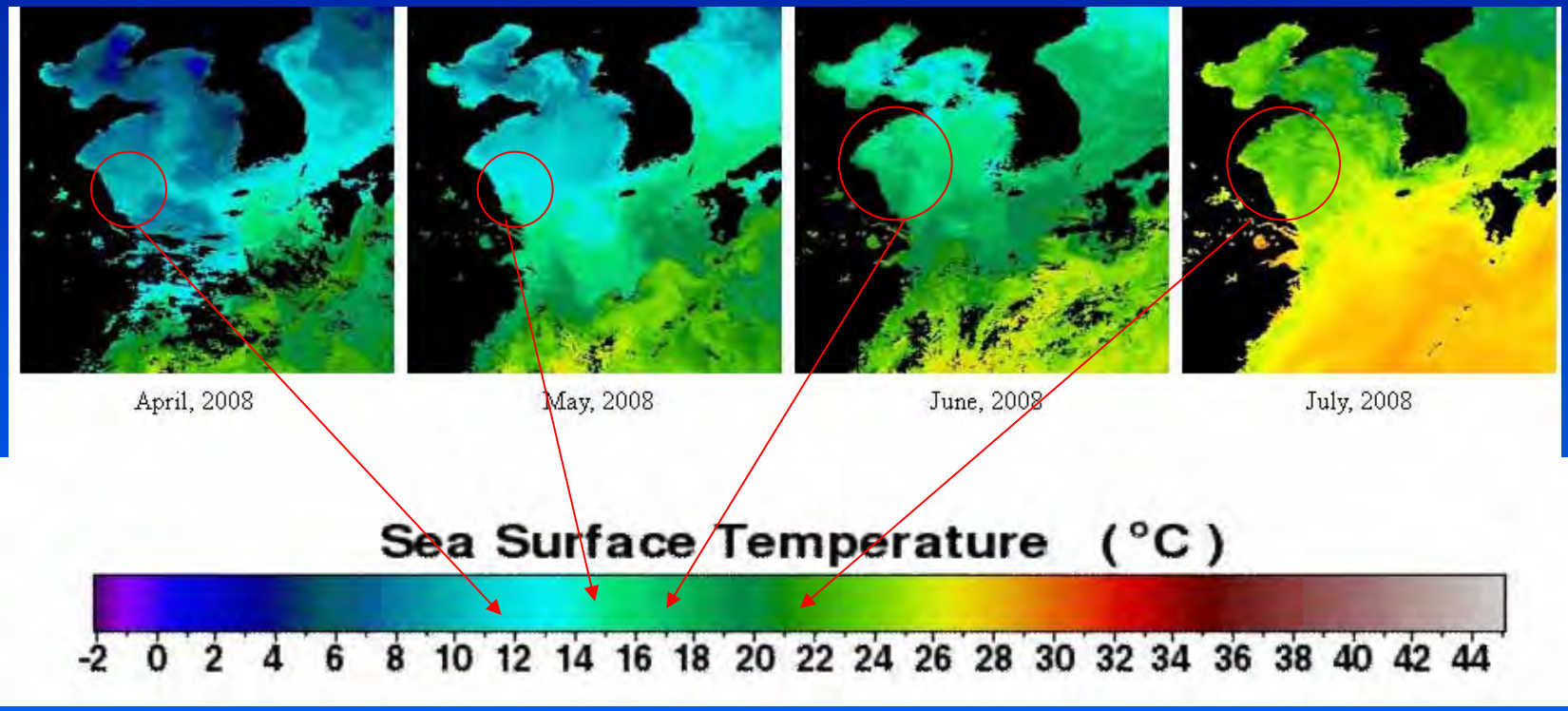
The temperature is very important for the occurrence of green tide





The temperature and occurring of floating green algae and large scale green tide in 2009 and 2010

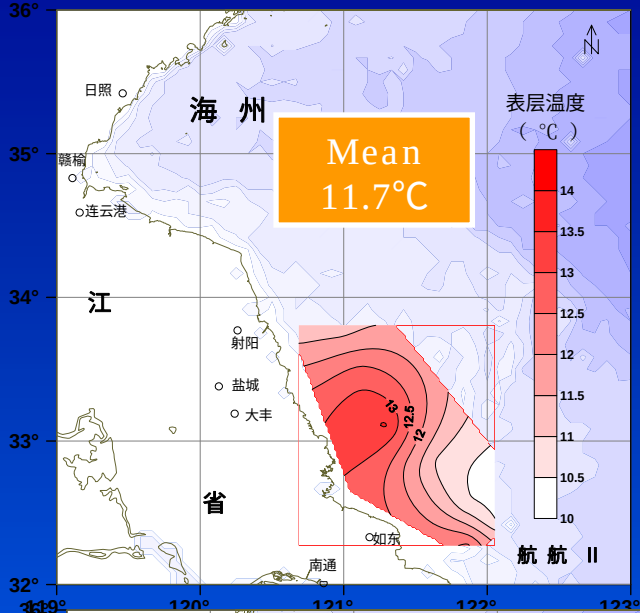
SST in April, May, June and July , 2008



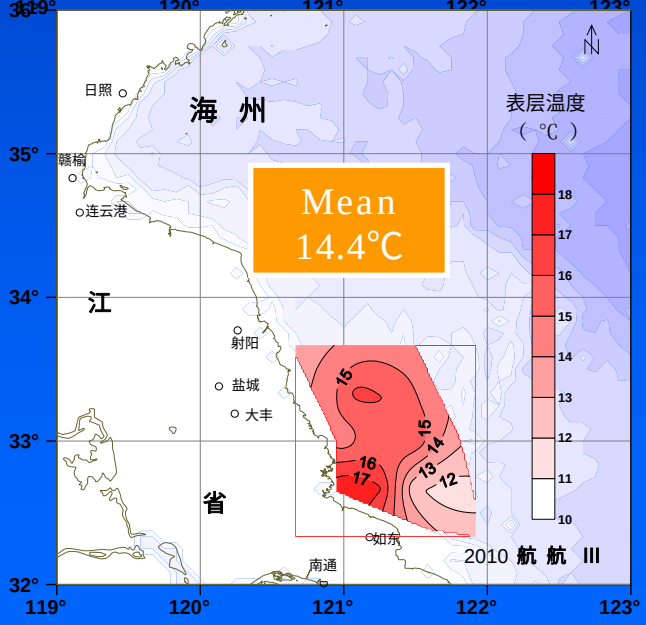
The temperature and occurrence of floating algae and large scale green tide

April 9-18, 2009

Early stage

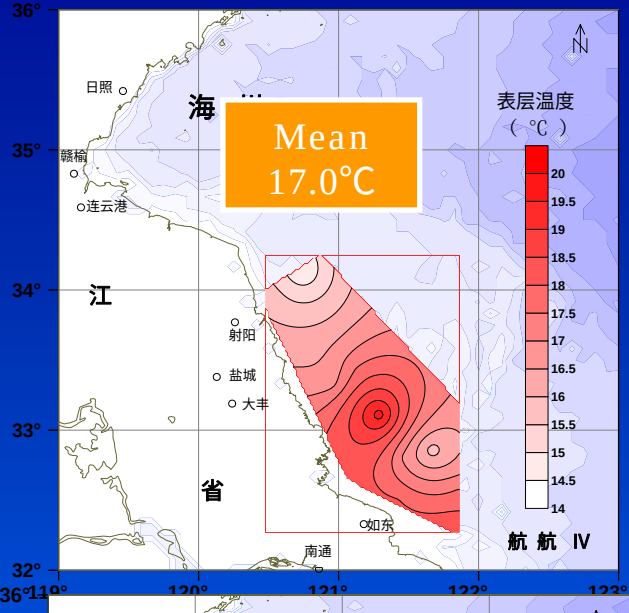


April 30-May 11, 2010

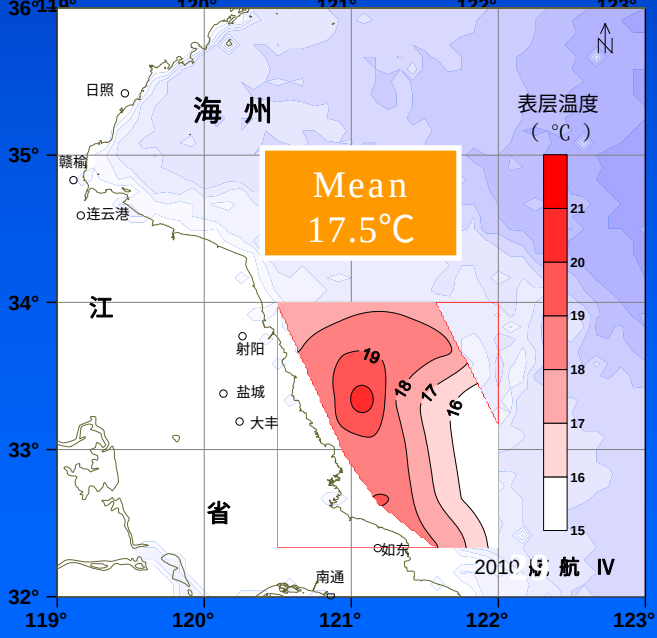


May 6-19 , 2009

Large scale

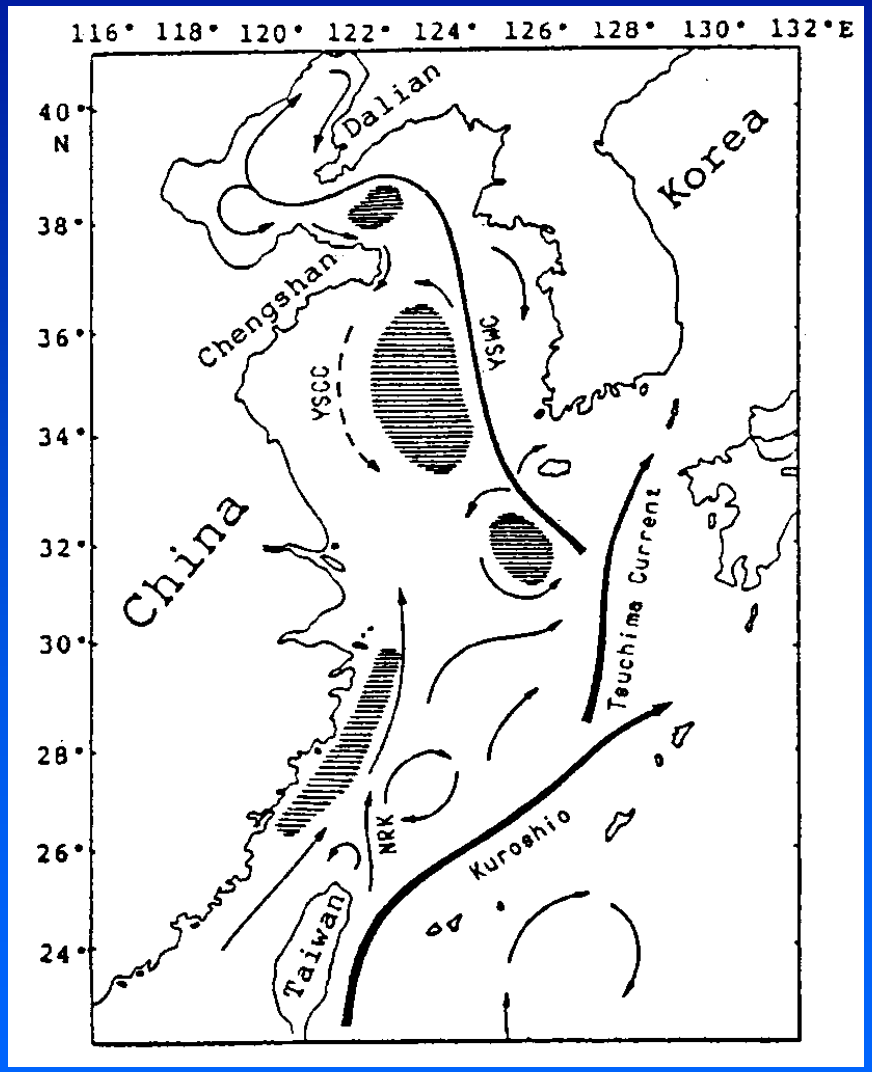


May 19-31, 2010



The results showed the fast growth occurred when temperature above 17℃

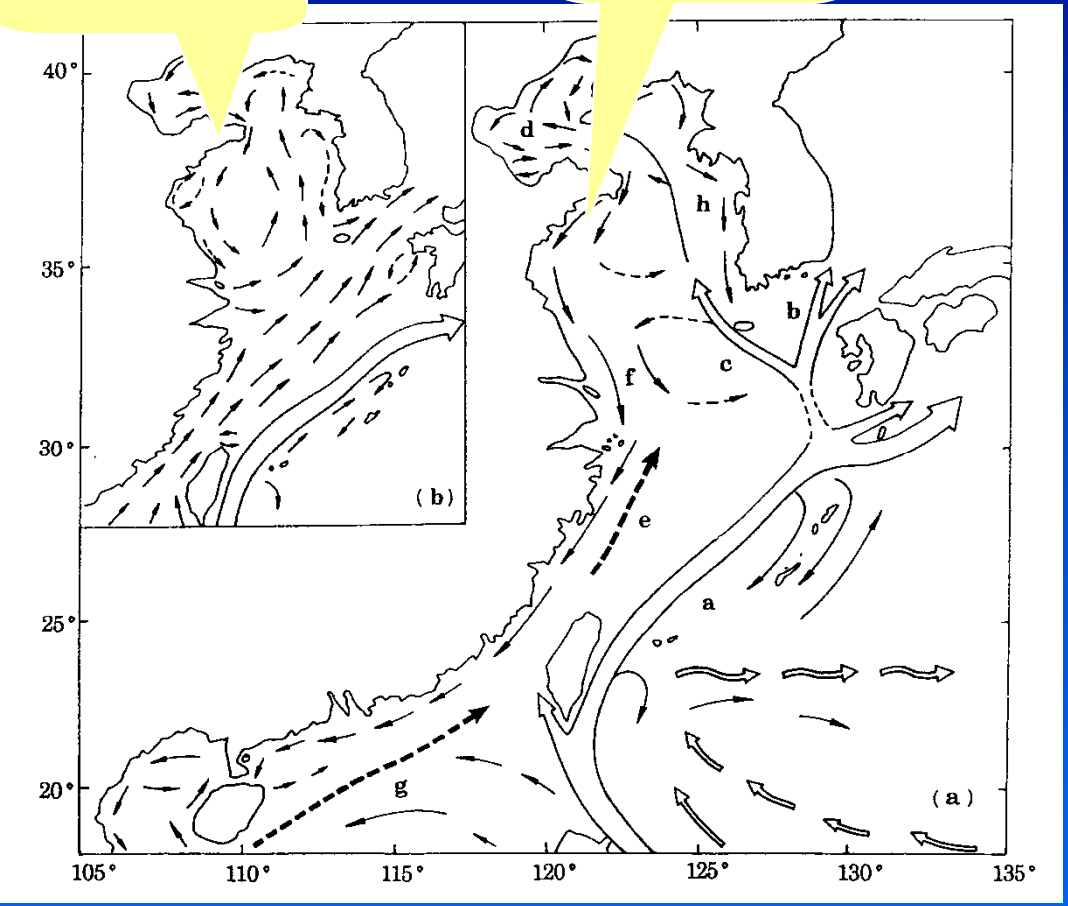
Historical results on circulation in Yellow Sea



Hu（1994）

Summer

Winter

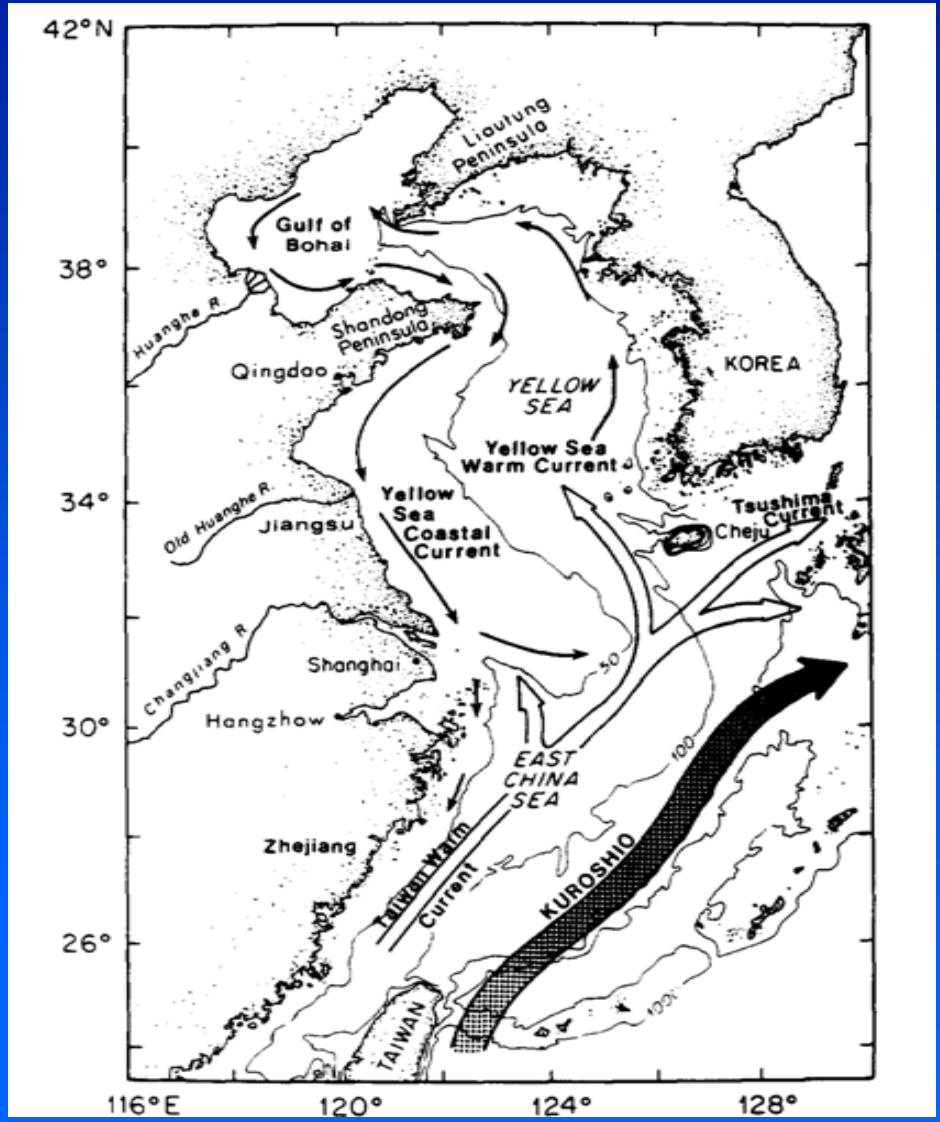


Guan（1994）

Thoughts from scientist of Woods Hole Institution

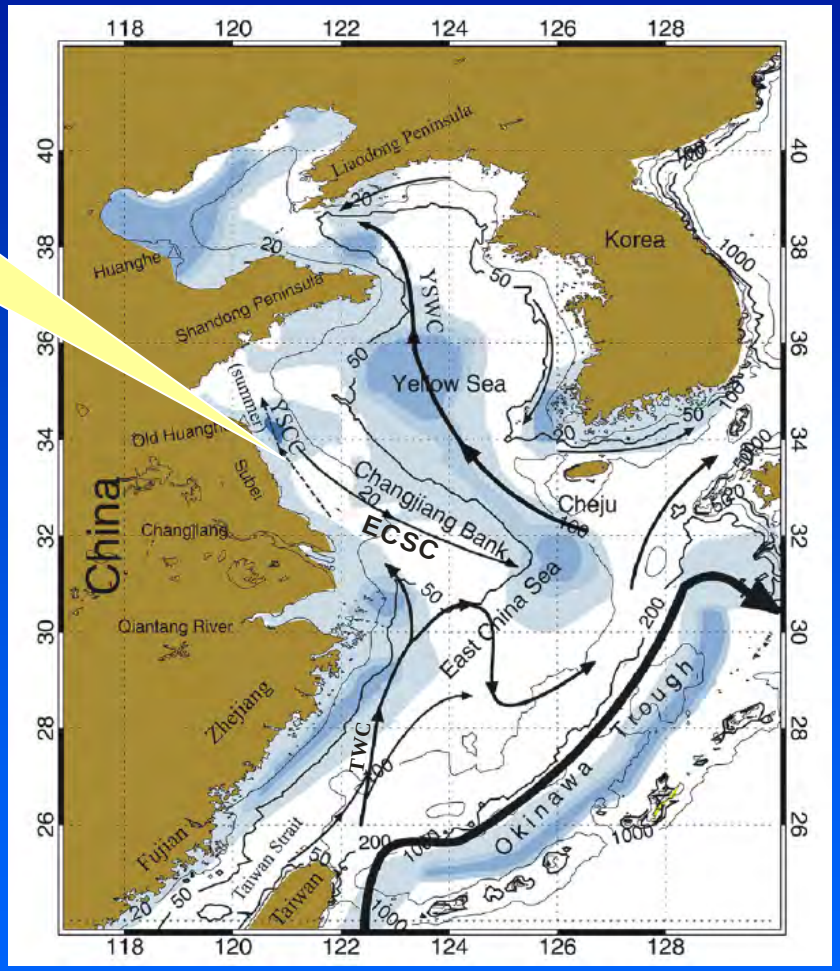
However, in summer a highly variable shallow surface plume of low salinity water exists in the *mean* hydrographic structure of the central East China Sea.
We believe that this low salinity surface plume is the result of offshore flow of Jiangsu coastal water from the north, some direct outflow from the Changjiang, and some offshore flow of Zhejiang coastal water from the south.

Beardsley et al. (1985)



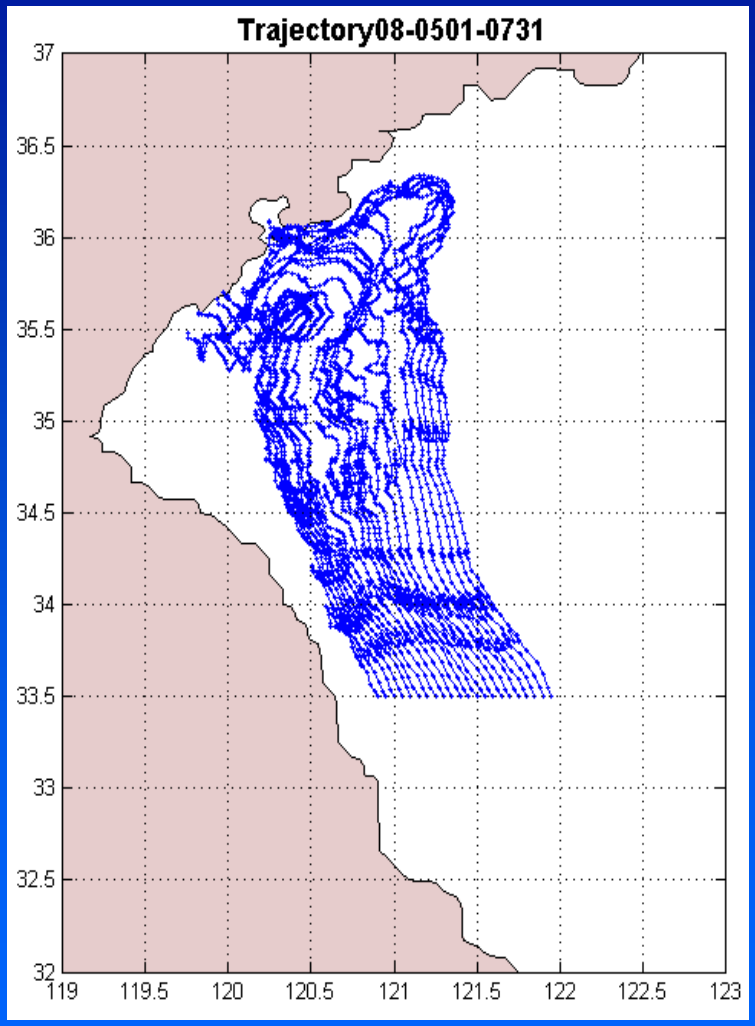
Recent results on summer circulation

Summer northward coastal current



Yuan et al（2008）J. Mar. Sys.

2008 simulated trajectories



From Yuan