

# The Programs of China Ocean Observation Satellites and Applications

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SOA, Feb. 26, 2008



**1、 The Objectives of Ocean Observation Program of China**

**2、 The Program before 2020**

**3、 The Achievement of China Ocean Satellites and Applications**



# 1 The Objectives of Ocean Observation

- Three series of Ocean Observation satellites and their application systems have been planned before 2020.
  - Ocean Color & Sea Surface Temperature (**HY-1** Series),
  - Ocean Dynamics (**HY-2** Series)
  - Marine Monitoring Satellite (**HY-3** Series).
- Objective 1: To establish China Ocean Observation System mainly based on the three satellite series
- Objective 2: To Improve the precision and time efficiency of ocean disaster monitoring and forecast.
- Objective 3: To provide services for the management of coastal zone integrate, exploitation of ocean resources and protection of ocean environment.
- Objective 4: Safeguard the maritime rights and interests of the nation.



## **2 The Program of China Ocean Observation Satellites before 2020**

### **2.1 HY-1 Series**

- The main task of HY-1 is ocean color & SST
  - Chlorophyll, suspended sediment, and dissolved organic matter, pollutants, as well as sea surface temperature.
  - HY-1A, launched on 15 May, 2002.
  - HY-1B, launched on 11 April, 2007.
  - HY-1A/B is power limited, only downloading in China
- HY-1C/D, will be launched ~2010.
  - 1C is AM and 1D PM.
- AM/PM satellites will be launched every 3 years
  - 2010, 2013, 2016, 2019.

# **HY-1B Satellite and orbit characteristics**

<b><i>Orbit type</i></b>	<b>Near Circular ,near sun-synchronous</b>
<b><i>Equator crossing local time</i></b>	<b>10:30±30 min (descending node)</b>
<b><i>Altitude</i></b>	<b>798km</b>
<b><i>Inclination</i></b>	<b>98.8 deg</b>
<b><i>Period</i></b>	<b>100.8 minute</b>
<b><i>Repeat observation period</i></b>	<b>1days for COCTS, 7days for CZI</b>
<b><i>Mass</i></b>	<b>&lt;400kg</b>
<b><i>Payload</i></b>	<b>COCTS and CZI</b>
<b><i>Attitude control</i></b>	<b>3 axis stabilized</b>
<b><i>Downlink frequency</i></b>	<b>X-band</b>
<b><i>TT&amp;C link</i></b>	<b>S-band</b>
<b><i>Designed life time</i></b>	<b>3 years</b>
<b><i>Platform</i></b>	<b>CAST968 small satellite</b>



# HY-1B COCTS Specifications

<b>Nadir Resolution: 1100m      Pixels per line: 1664</b>		
<b>Field-Of-View: <math>\pm 55^\circ</math>      Digitization: 10 bits</b>		
<b>Accuracy Goal: VNIR-10%, TIR:1K</b>		
<b>BandNo.</b>	<b>Wavelength(<math>\mu</math>m)</b>	<b>VNIR Polarization: <math>\sim 7\%</math></b>
<b>1</b>	<b>0.402<math>\sim</math>0.422</b>	<b>Gains: 1</b>
<b>2</b>	<b>0.433<math>\sim</math>0.453</b>	<b>4-detecotors</b>
<b>3</b>	<b>0.480<math>\sim</math>0.500</b>	<b>45<math>^\circ</math> Scan-mirror &amp; K-mirror</b>
<b>4</b>	<b>0.510<math>\sim</math>0.530</b>	<b>Sterling Cooler</b>
<b>5</b>	<b>0.555<math>\sim</math>0.575</b>	
<b>6</b>	<b>0.660<math>\sim</math>0.680</b>	
<b>7</b>	<b>0.740<math>\sim</math>0.760</b>	<b>B 9: 10.30<math>\sim</math>11.40 <math>\mu</math>m</b>
<b>8</b>	<b>0.845<math>\sim</math>0.885</b>	<b>B10: 11.40<math>\sim</math>12.50 <math>\mu</math>m</b>



## ***HY-1A CZI bands & detecting objectives***

<i><b>Band ( micro m</b></i>	<i><b>Main detecting object</b></i>
<i><b>0.42-0.50</b></i>	<i><b>Ocean color, pollutant, sea ice</b></i>
<i><b>0.52-0.60</b></i>	<i><b>Sediment, Pollutant, sea ice</b></i>
<i><b>0.61-0.69</b></i>	<i><b>Sediment, Vegetation, Soil、</b></i>
<i><b>0.76-0.89</b></i>	<i><b>Soil, Vegetation, Atmospheric correction, land/ocean/cloud boundary</b></i>

**Resolution: 240m**

**Pixels per line: 2048**



## **HY-1B CZI bands**

<b><i>Band</i></b>	<b><i>Detecting objects</i></b>
<b><i>443±10nm</i></b>	<b><i>Chl-a, pollutant</i></b>
<b><i>565±10nm</i></b>	<b><i>Sediment, Chl-a, Pollutant</i></b>
<b><i>665±10nm</i></b>	<b><i>Flourescence, Sediment</i></b>
<b><i>685±10nm</i></b>	<b><i>Flourescence, Sediment</i></b>

**Its atmospheric correction depends on COCTS !**





## **2 The Programming of China Ocean Observation Satellite before 2020**

### **2.2 HY-2 Satellite Series**

- The Object of HY-2 series satellite:
  - Global Ocean Wind Field
  - Global Ocean Topography, Sea Level and Gravity Field.
  - Wave Field.
  - All weather Sea Surface monitor and forecast
  - Sea Ice monitor
  
- Will be launched in 2009, 2012, 2015, 2019.



## HY-2 series satellite Monitor Parameter

Payload	Monitor Parameter
Scatterometer	<b><u>Main Parameter:</u></b> Sea Surface Wind Field
Altimeter	Sea Surface height, Significant wave height, Gravity field and Ocean Circumfluence
Radiometer	Sea Surface Temperature Wind Speed Sea Ice and Vapor content



## HY-2 Series Satellite Orbit Select

- Monitor Global Wind: Cover more than 90% in 1 day.
- Regress Period are of two cycles: one is 14days and the other is 168days.



## HY-2 Satellite Characteristics

- Point precision: pitching ,roll and yawing $<0.1^{\circ}$
- Measure precision: pitching ,roll and yawing $< 0.05^{\circ}$
- Three axis pose stability  $<0.001^{\circ}/s$
- Repeat Cycle: two phases ( 14days and 168days )
- Life: more 3years。



## Payload user requirement

### (1) SCAT

wind speed range: 2-24m/s

wind direction precision:  $\pm 20^\circ$

wind speed: 2m/s or 10%

### (2) ALT

Sea Surface precision: <5-8cm

SWH range: 0.5-20m

SWH precision: <10% or 0.5m(greater)



## Payload user requirement (con.)

(3) RAD

wind speed:

range: 7-50m/s

precision: 2m/s or 10%(greater)

SST:

range: 100-300K

precision: 1.0K

Vapor:

precision: 10%



## Payload Specifications

### ● Scatterometer

- frequency: 13.2515GHz
- polarizae: HH, VV
- scan coverage: >1300KM
- ground resolution: 50km
- backscatter coefficient precision: <0.5dB
- backscatter range: -40~20dB
- dynamics range: AGC 60dB



## ● Altimeter

- frequency: 13.58 and 5.25 GHz
- compress ratio: 33000
- pulse repeat frequency: 1~4KHz
- ground resolution: 16km
- SSH precision:  $<4.0\text{cm}$
- backscatter precision: 0.5dB





## ● Radiometer

freq.(GHz)	6.6	10.7	18.7	23.8	37
Bandwidth(MHz)	350	250	250	400	1000
Polarize	VH	VH	VH	V	VH
Swath	1600km				
Resolution	100	62	36	30	18
Sensitive	0.5	0.5	0.5	0.5	0.8
range	3-350K				
Precise	1K (180-320K)				
Linearity	>0.999				



## HY-2 Satellite Precision Orbit Determine requirement

**Satellite radius vector direction precision: 10cm**

POD system is composed of :

**DORIS+laser system +GPS (Double frequency)**


The SSH Accuracy Goal: 4~5cm



## 2 The Programming of China Ocean Observation Satellite before 2020

### 2.3 The HY-3 series satellite:

#### ■ HY-3 Mission Objectives:

 To obtain high resolution data of ocean **targets, waves, oil spills, winds, currents, coastal engineering, coastal zone resources**.

(2) To provide services for safeguard the state's **maritime rights** and interests, marine **law enforcement**, rapid response to national security, marine **environmental protection**, monitoring of **marine pollution**, exploitation of marine resources, **Coastal zones survey**, management of marine resources, polar study and research, etc.



## ■ HY-3 Payload

SAR



## **2 The Programming of China Ocean Observation Satellite before 2020**

The HY-3 series satellite:

- HY-3 Satellite Project schedule:
  - 2005 — 2006: User requirements analysis
  - 2007 — 2008: Key techniques research
  - 2009 — 2011: Sensor & Satellite manufacture
  - 2012: launch
- We will launch one HY-3 satellite every 5 years
- 2012, 2017, 2022

## WSAR parameters

basic param eters	F re quency	X		
	P olarization	H H V V		
	incidence angle	15 <sup>0</sup> -60 <sup>0</sup>		
	N E σ	<-20db		
sw ath	Precise m odel	reso lution	1m *1m	
		sw ath	20—40km	
	Strip m odel	reso lution	5m *5m	
		60—80km		
	ScanSA R	reso lution	10m *10m	
		120—150km		
Im age quality	azim uth am biguous		<-20db	
	R ange am biguous		<-20db	
	dynam ic range	>30db		
	Precision	1db (1scene)1.5db (1orb it)		



## Platform features

Technical parameters name	Parameter values
Attitude control mode	Three-axis stably
Pointing accuracy	pitch、roll、yaw $<0.1^{\circ}$
Measurement accuracy	pitch、roll、yaw $<0.05^{\circ}$
Attitude stability	$<0.001^{\circ}/s$
Life time	Not less than 3 years
Data transmission	X-band, QPSK / QPSK , Realtime or delay
Data storage	400GB
Instrument operation requirements	$>30$ minutes each orbit
orbit	Sun-synchronous



## HY-3 Applications

- Ship activities, oil platform operations;
- The changes of coastal line, islands and reefs etc;
- Information services for EEZ management and monitoring;
- Monitor ocean waves, oil spills, sea ice, bathymetry, internal waves, fronts and eddies, coastal zones, ocean disaster prevention and relief.

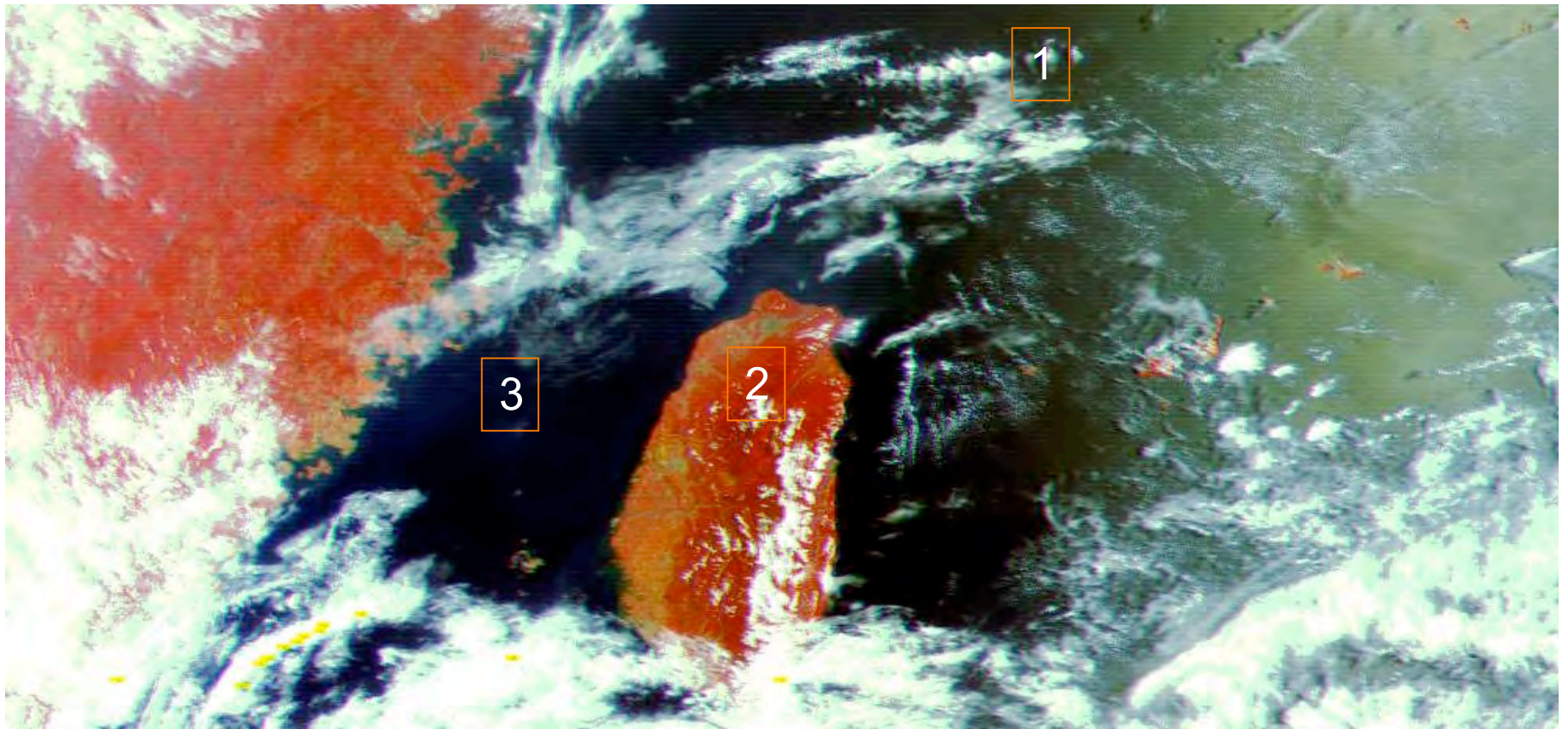




# The Schedule of China Ocean Satellites

	2002	2007	2010	2012	2013	2016	2017	2019
<b>HY-1</b>	<b>1A</b>	<b>1B</b>	<b>1C/1D</b>		<b>1E/1F</b>	<b>1G/1H</b>		<b>1I/1J</b>
<b>HY-2</b>			<b>2A</b>		<b>2B</b>	<b>2C</b>		<b>2D</b>
<b>HY-3</b>				<b>3A</b>			<b>3B</b>	

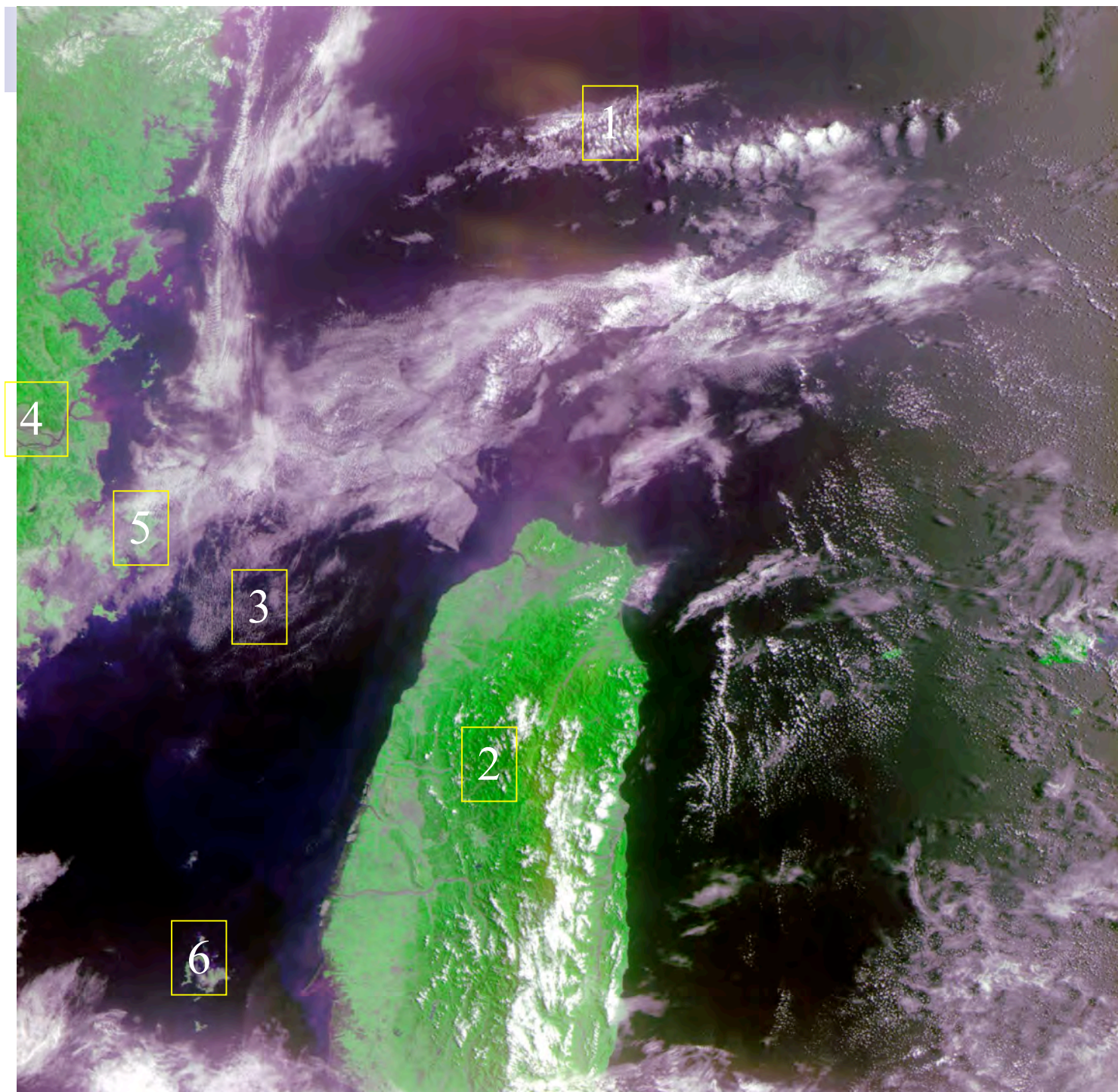
### 3 The Achievements of China Ocean Satellites and Applications



(BJT 2002.5.29 9:07 865/670/443)

HY-1A First COCTS Image in Real Time

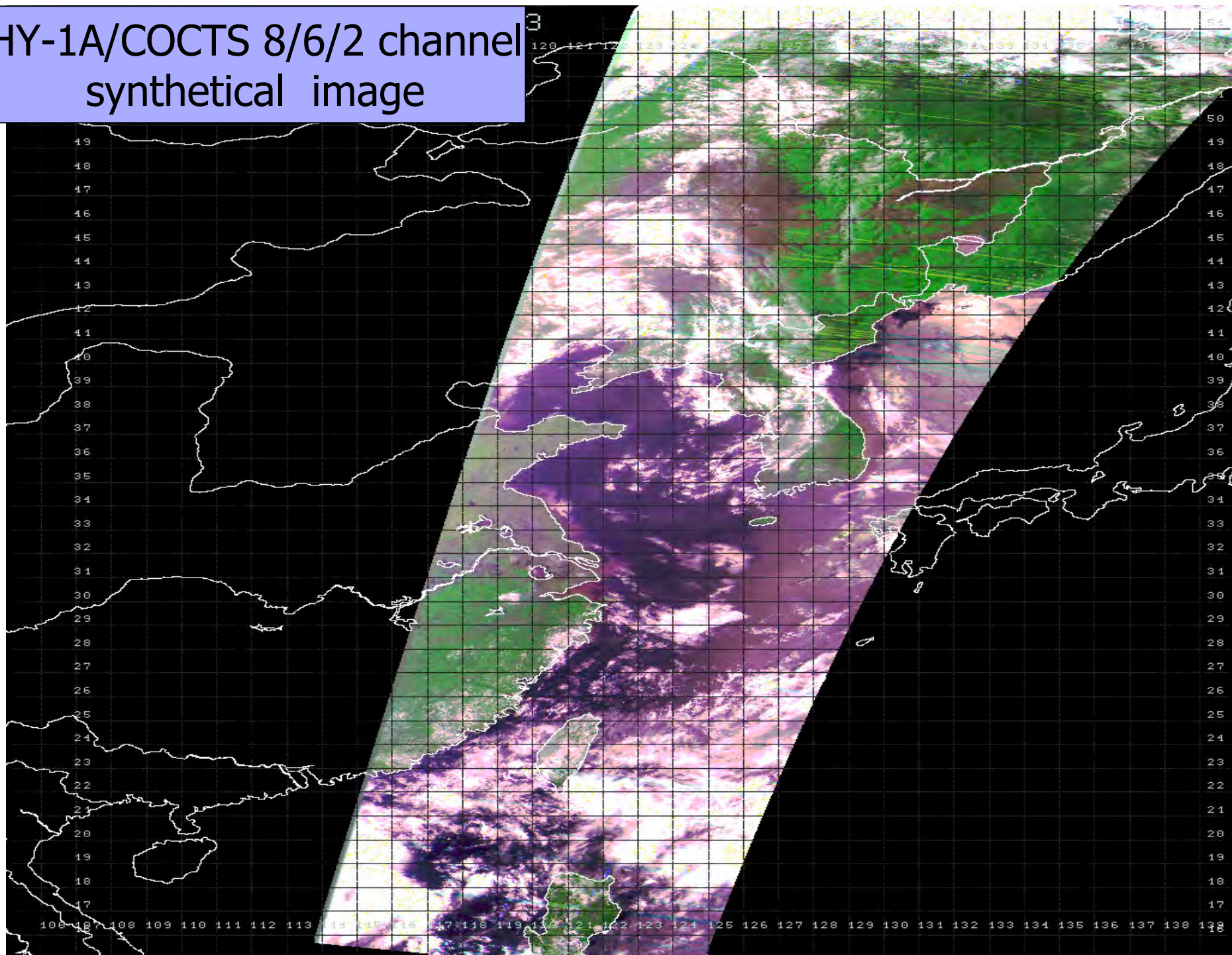




**HY-1A First  
CZI Image**  
2002.5.29 9:07

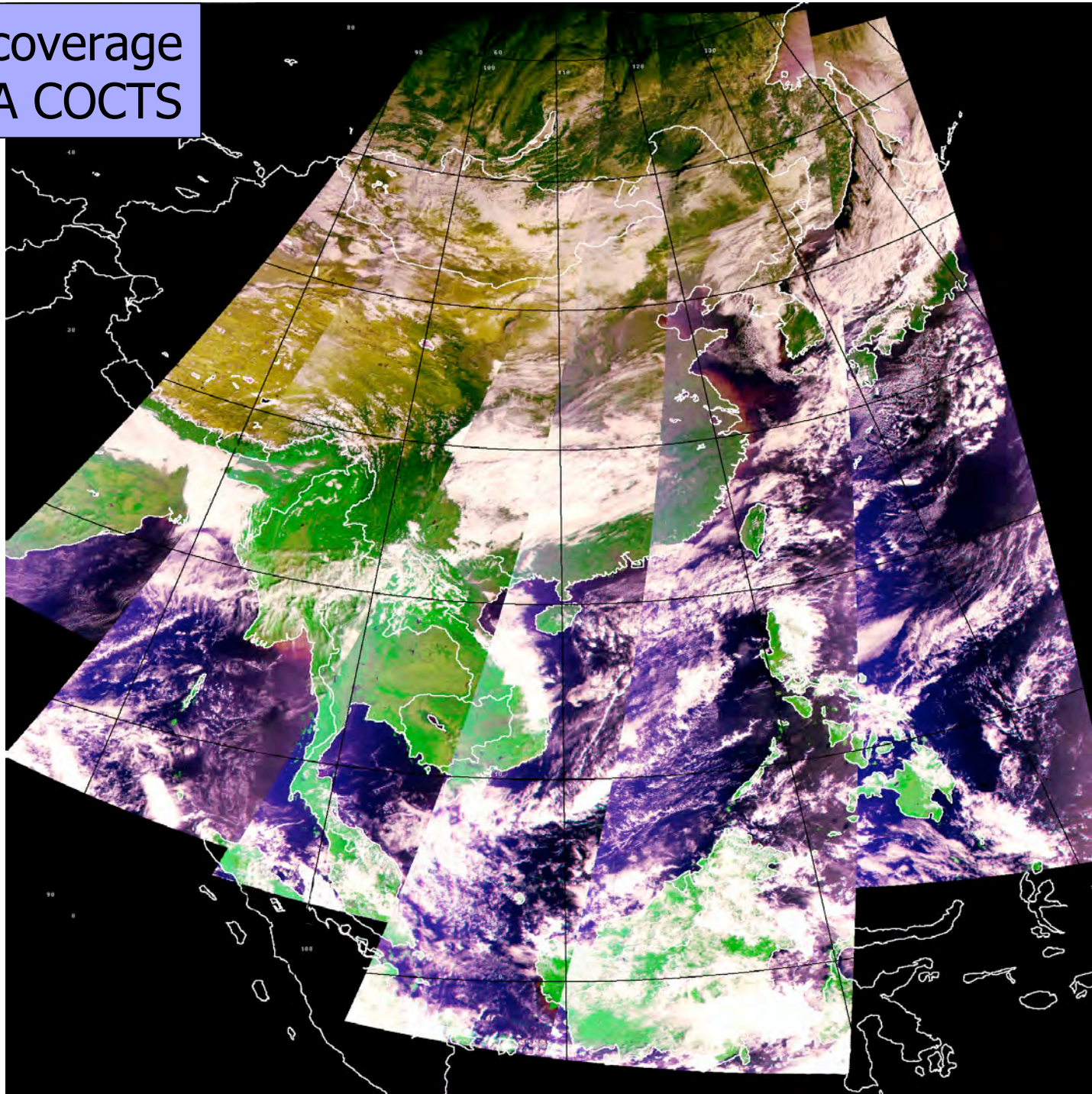


HY-1A/COCTS 8/6/2 channel  
synthetical image



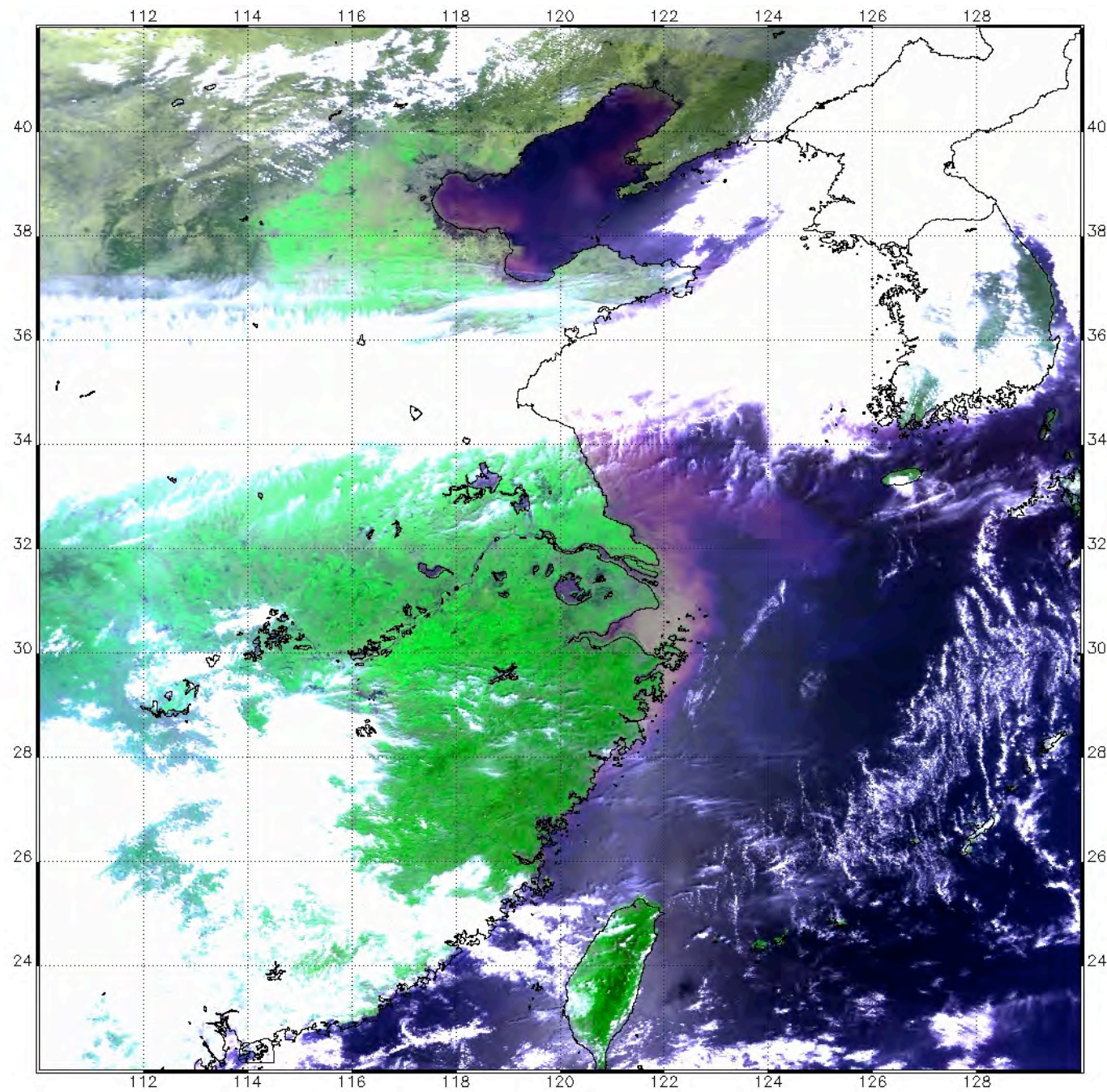


# 3 Days coverage of HY-1A COCTS



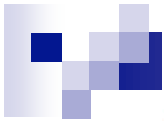
mosaic





HY-1B  
20 April  
First  
COCTS Image





海洋一号 B 卫星第一轨遥感影像图  
(CZI B4/B2/B1)

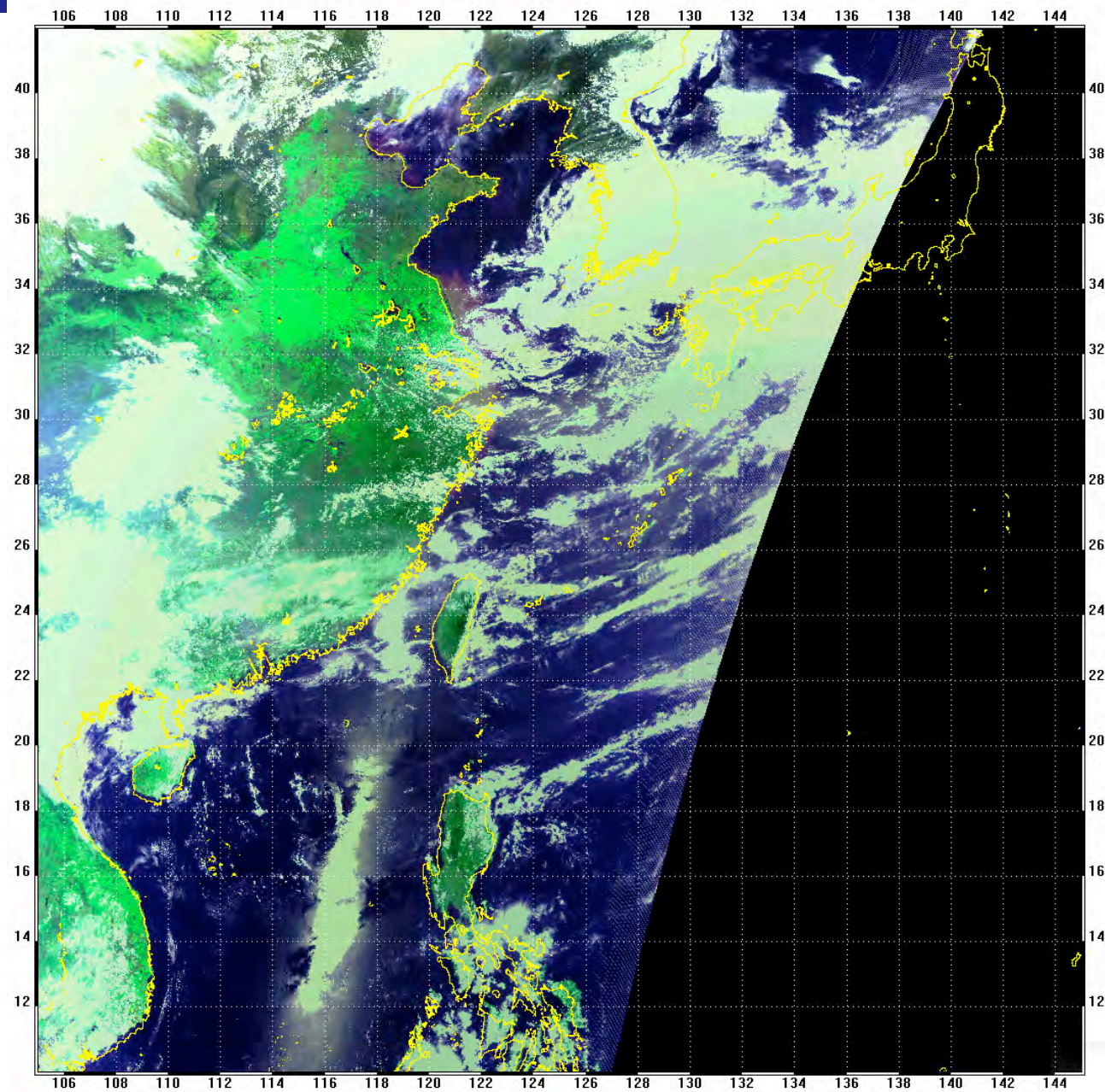
2007-04-20



HY-1B  
20 April  
First  
CZI Image

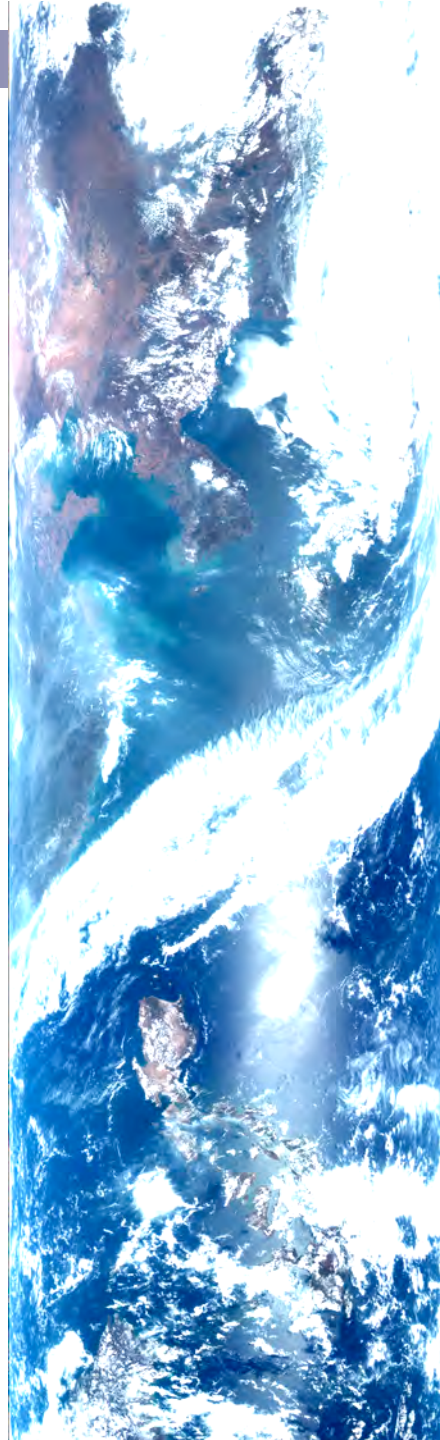
国家海洋局  
国家卫星海洋应用中心





HY-1B Projection  
Image (located)  
COCTS  
24 April COCTS





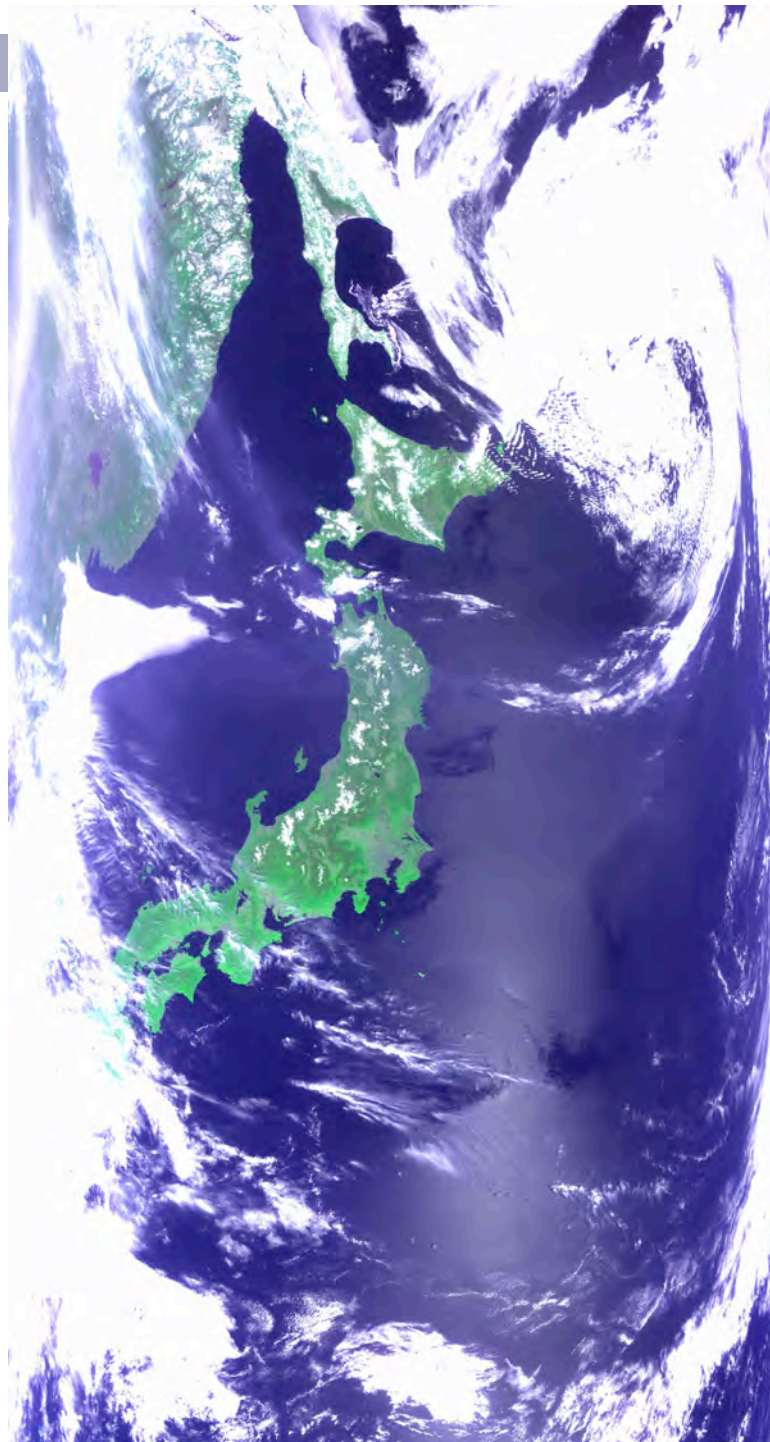
**Part of HY-1B  
COCTS one orbit  
image**

**HY-1B CZI  
Image**



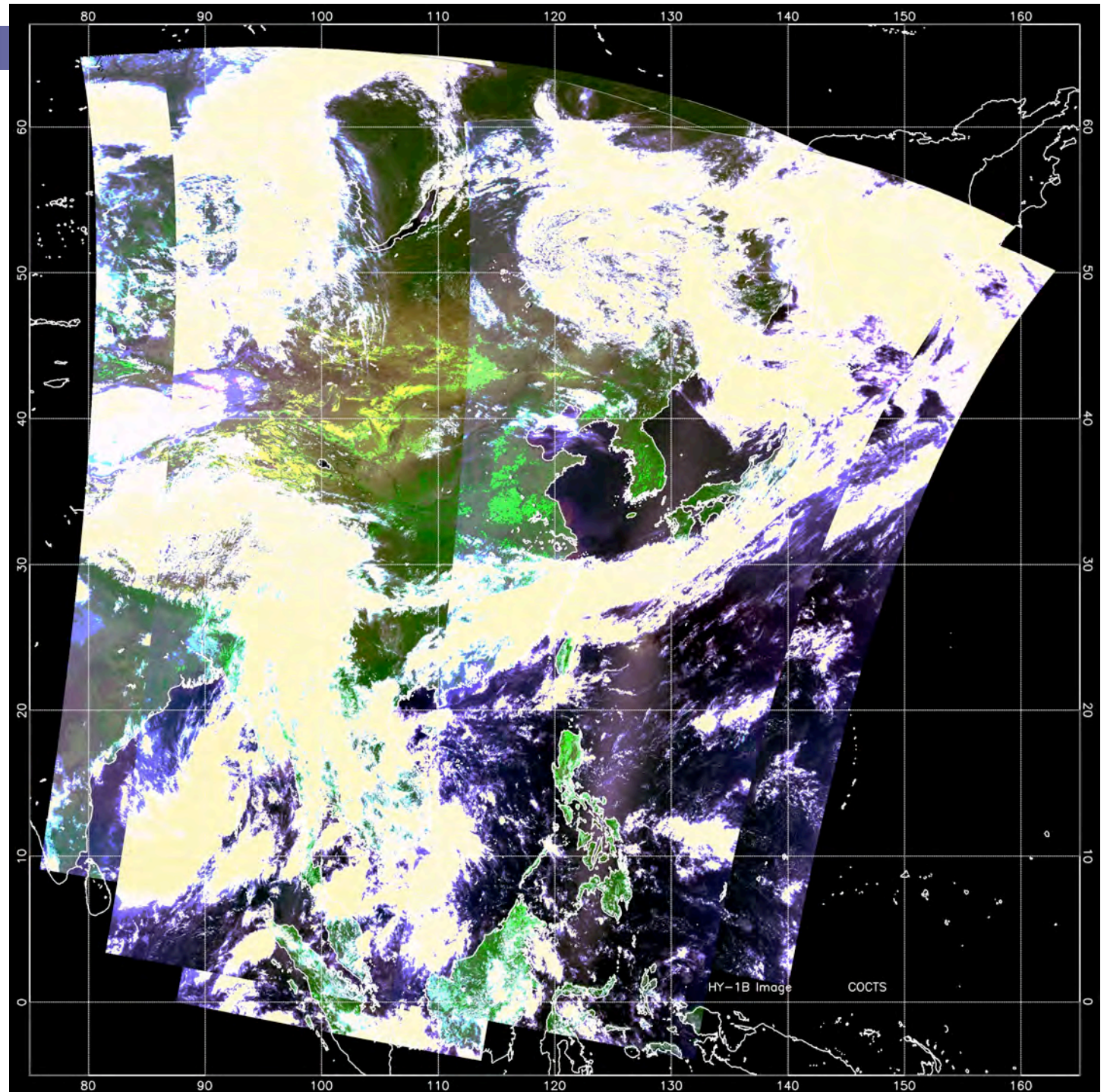


# **HY-1B CZI Image**

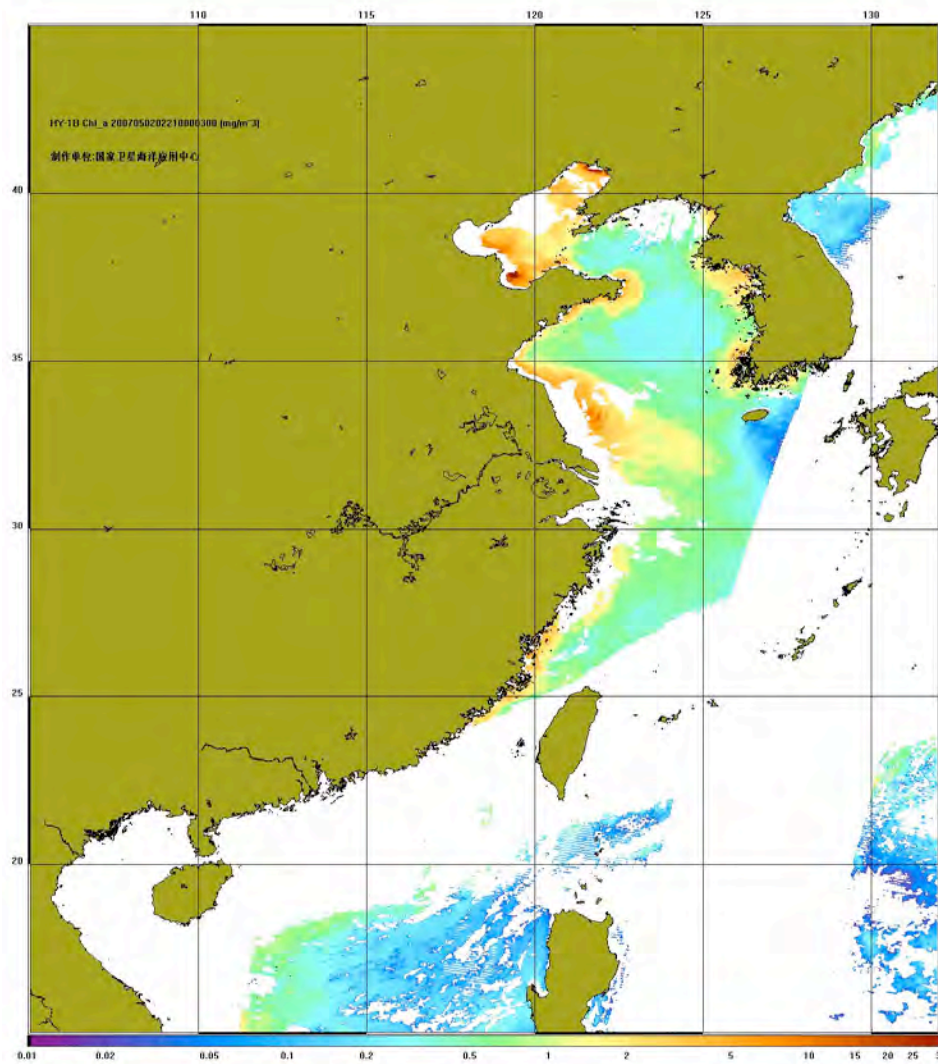


# HY-1B COCTS

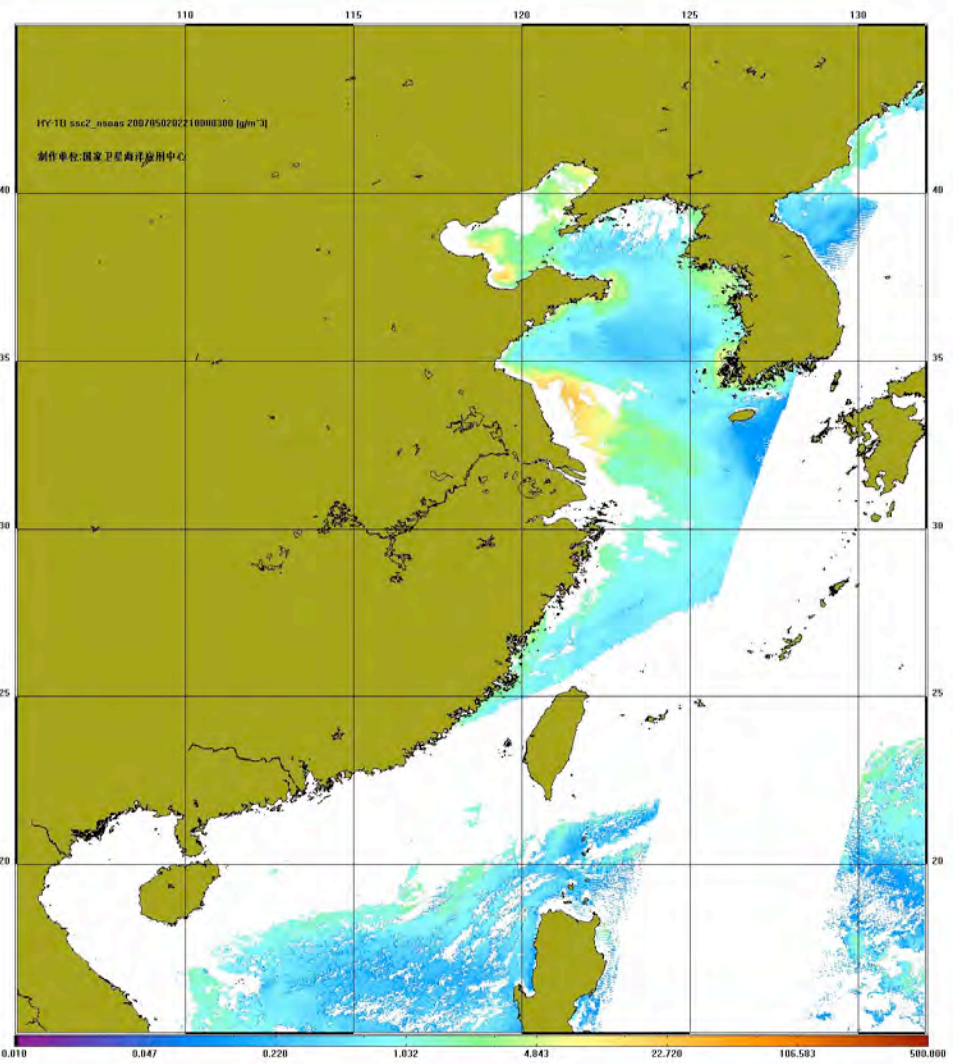
2 station  
3 days  
coverage







Chl-a



Sediment

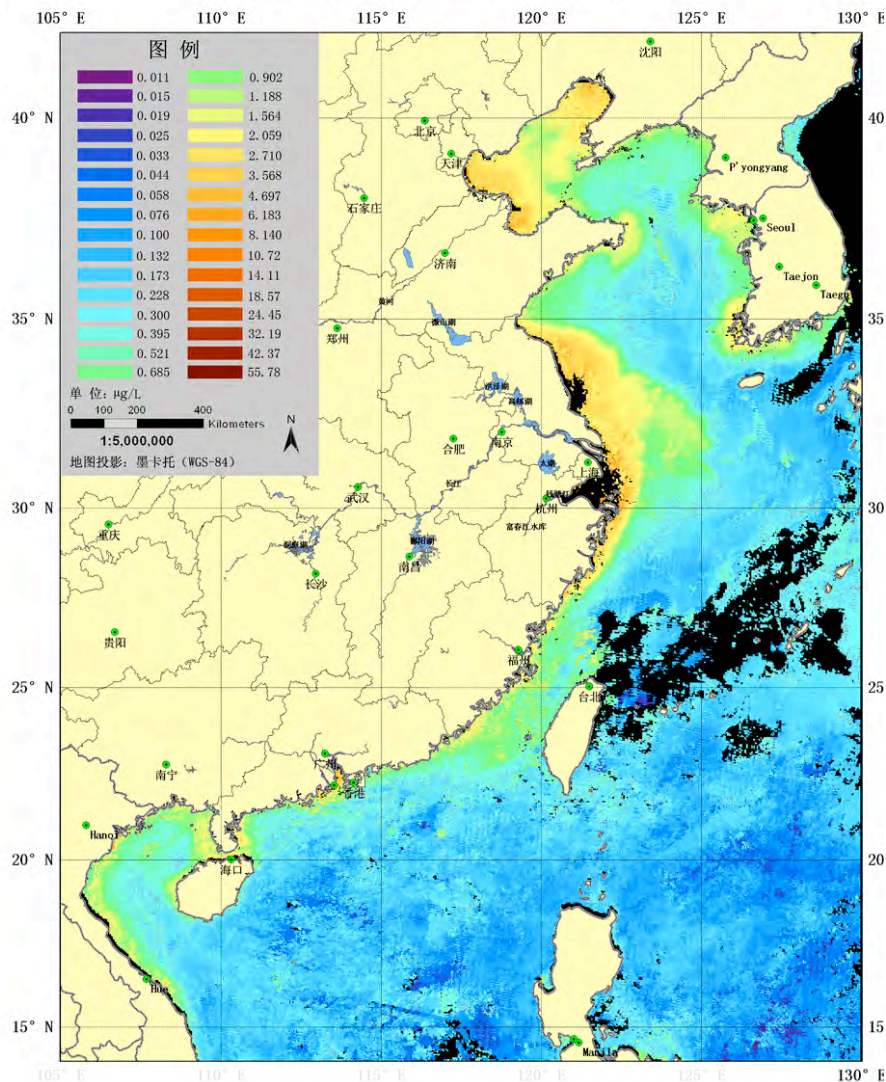
2008.5. 2 HY-1B/COCTS results



# HY-1B/COCTS & Aqua/MODIS (Chl-a)

卫星遥感水体叶绿素浓度专题图

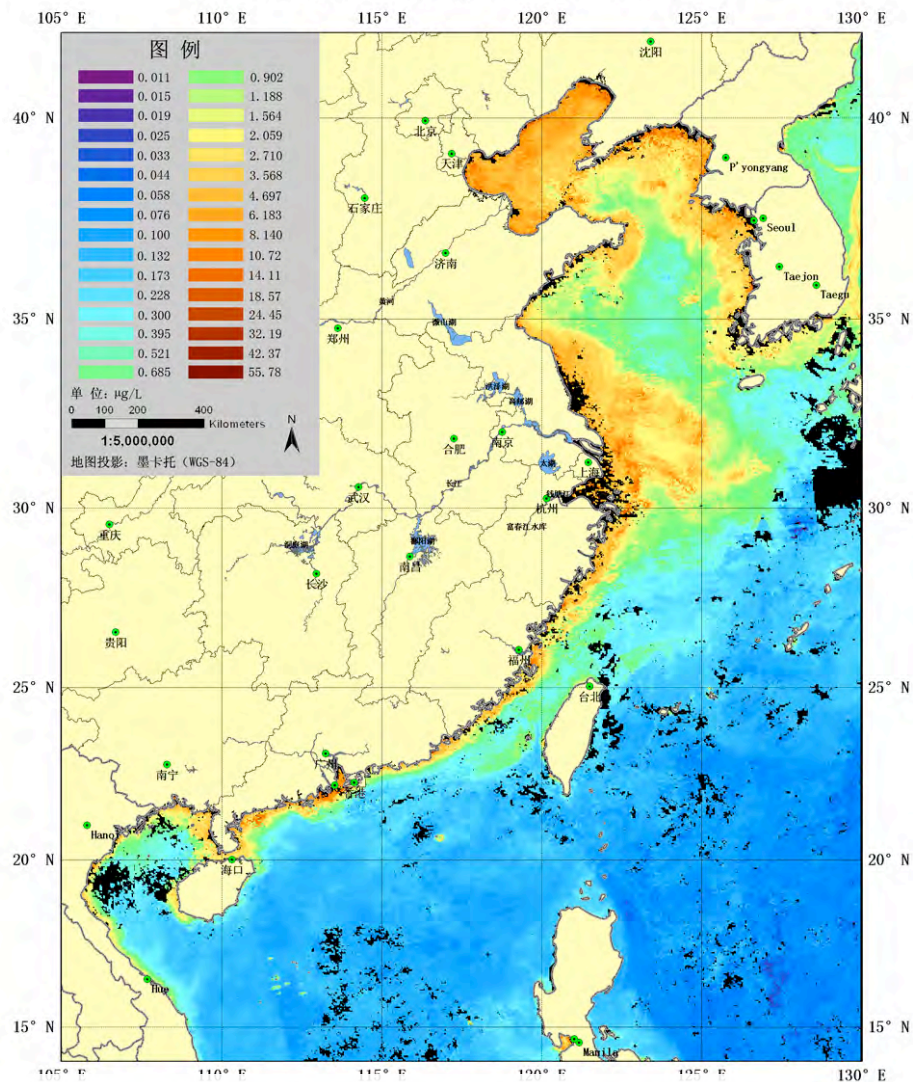
(资料时间: 年 月 日- 年 月 日)



5月份, HY-1B

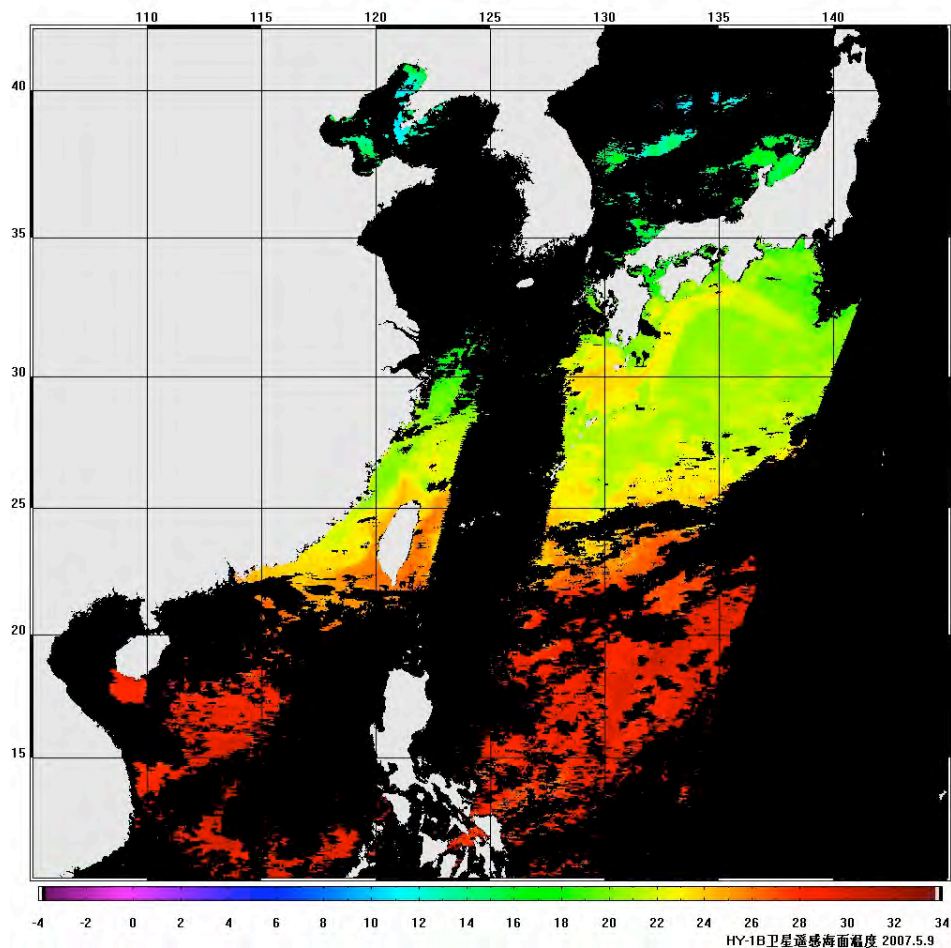
卫星遥感水体叶绿素浓度专题图

(资料时间: 年 月 日- 年 月 日)

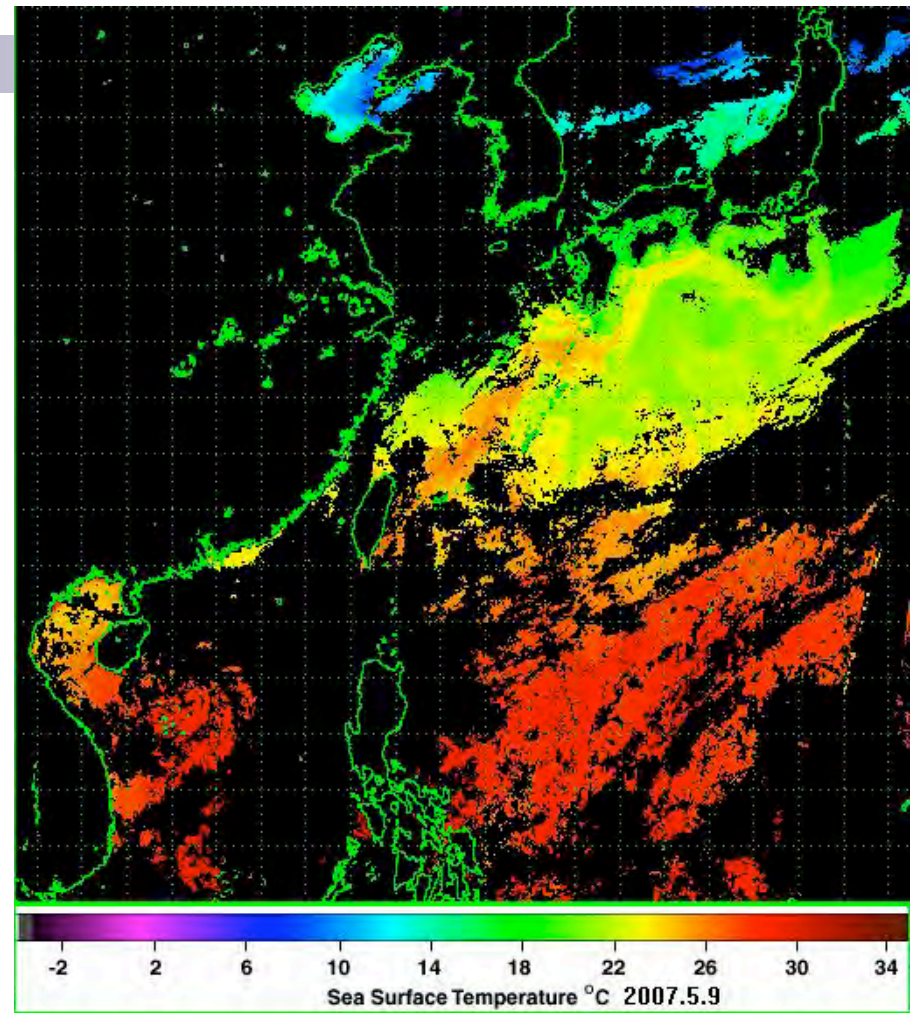


5月份, MODIS



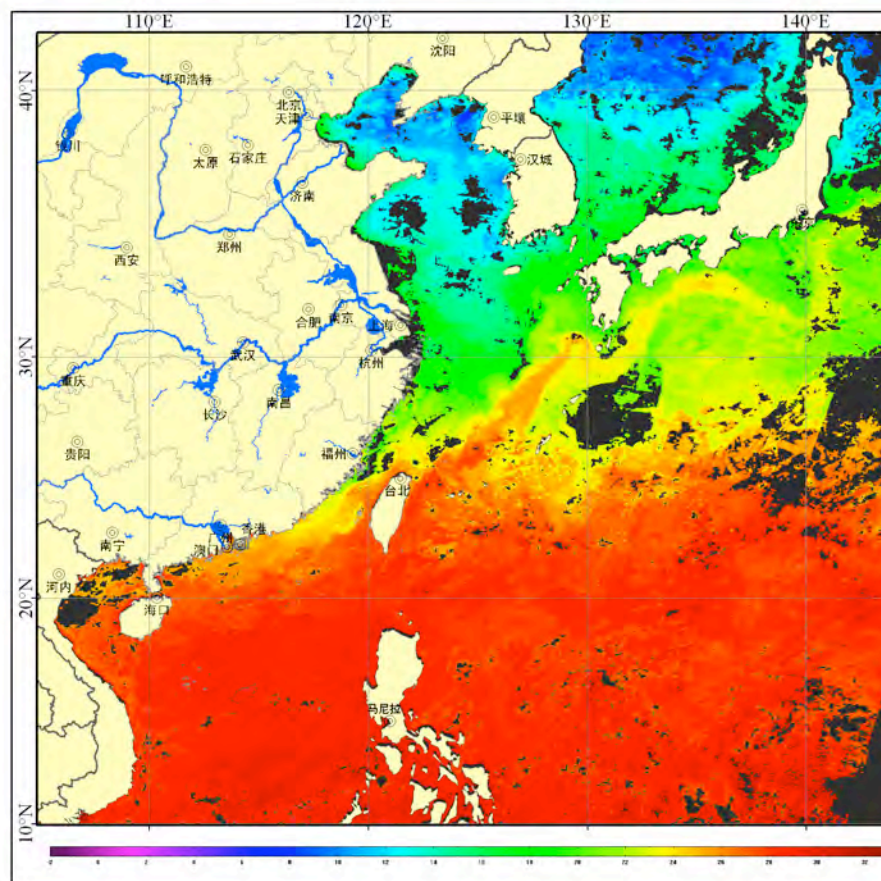


**2007.5.9**  
**HY-1B/COCTS SST**



**2007.5.9**  
**MODIS SST**

## HY-1B卫星遥感海面温度专题图



HY-1B卫星遥感海面温度（2007年05月 日）

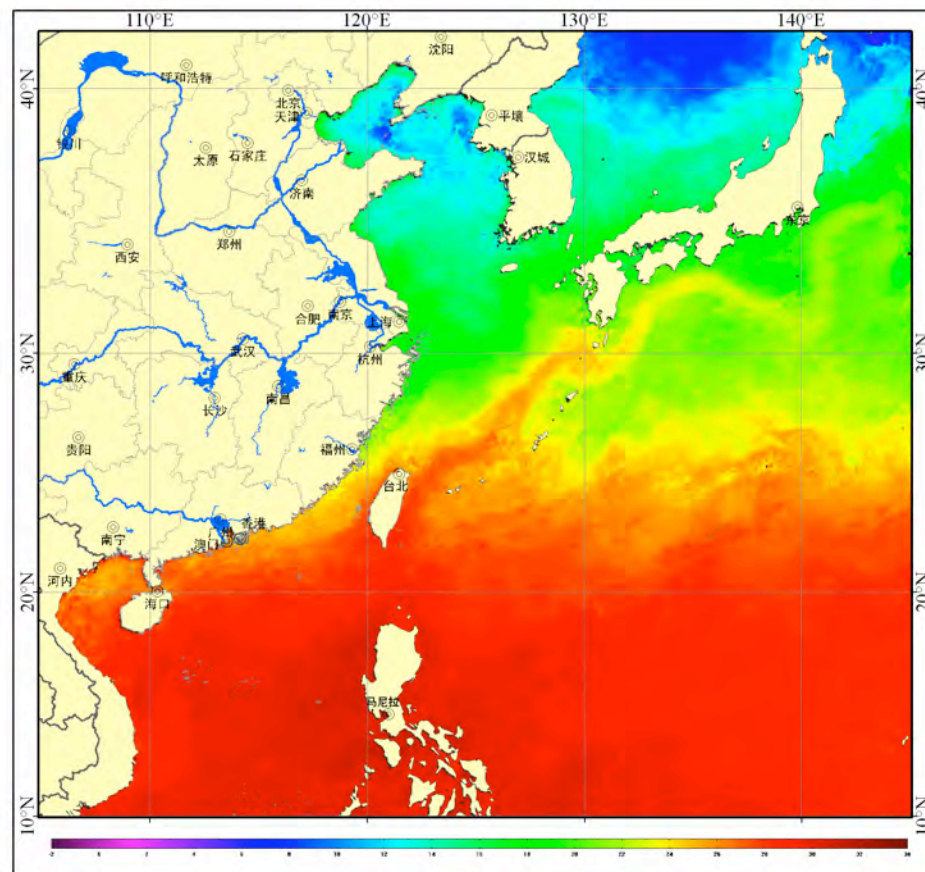
制作时间：2007年09月 日

地图投影：麦卡托投影（WGS-84）

制作单位：



## MODIS卫星遥感海面温度专题图



MODIS卫星遥感海面温度（2007年05月 日）

制作时间：2007年 月 日

地图投影：麦卡托投影（WGS-84）

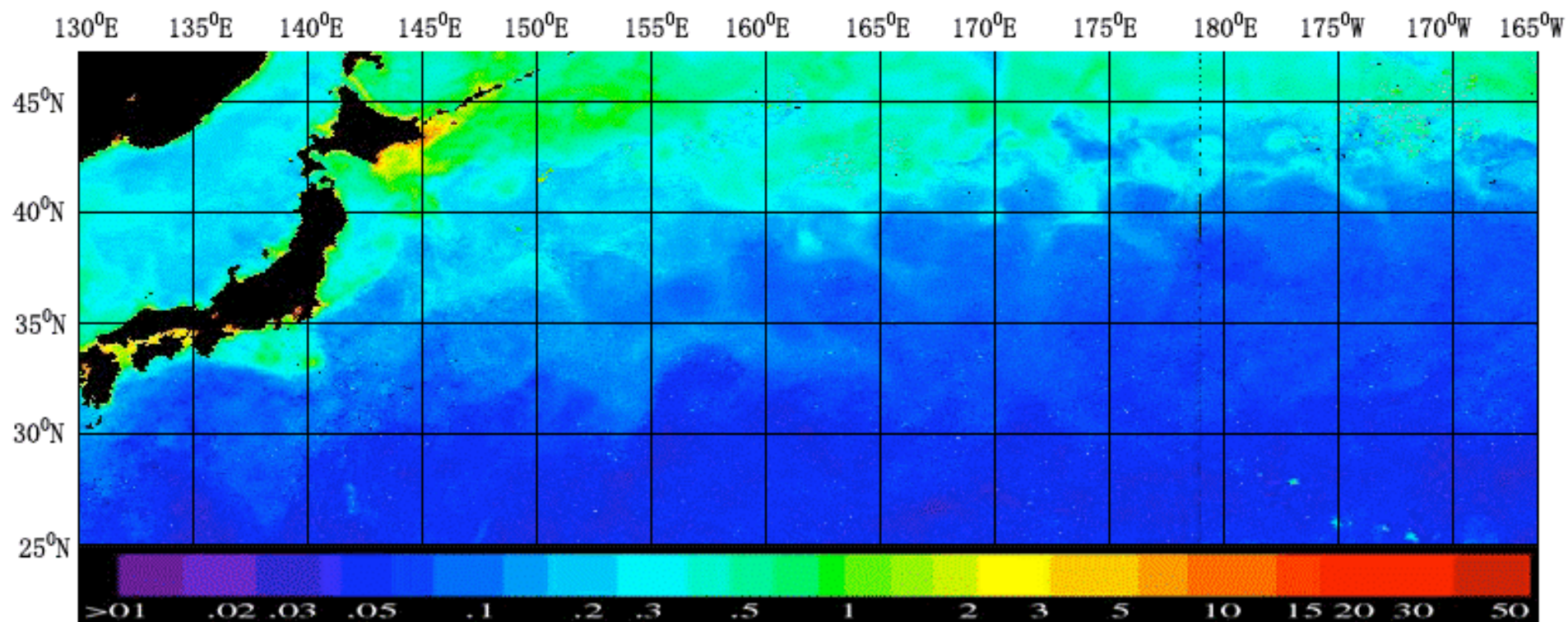
制作单位：



COCTS SST

MODIS SST

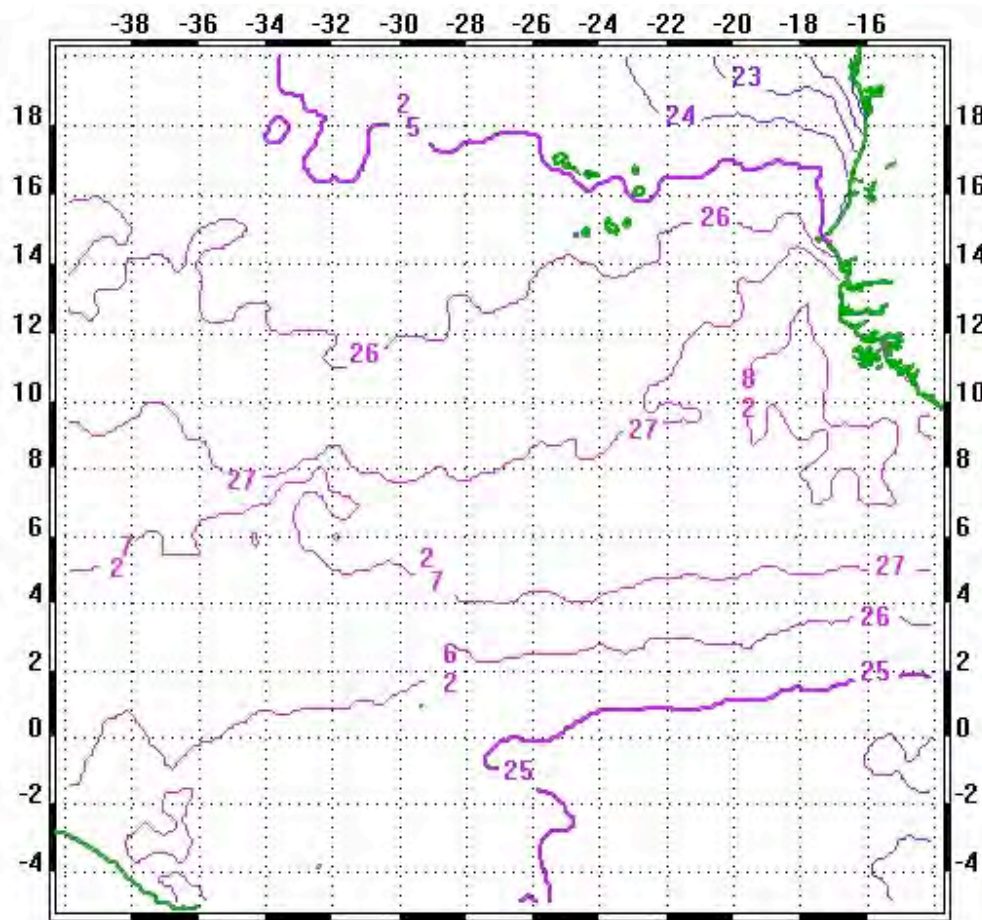




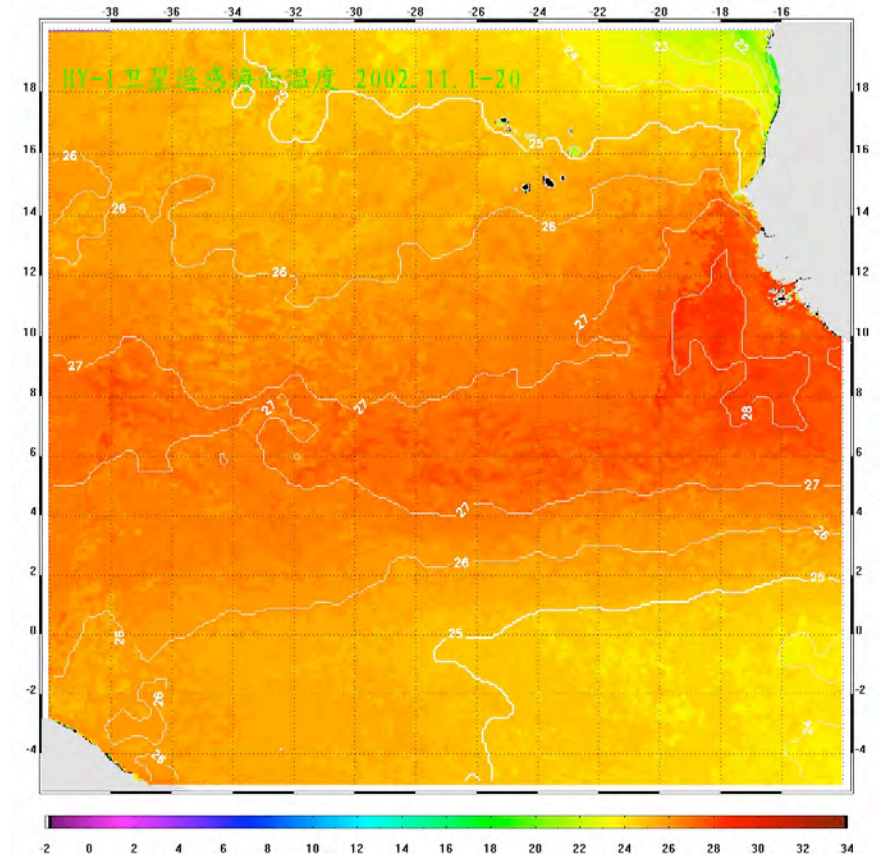
叶绿素a浓度/ $\text{mg}\cdot\text{m}^{-3}$  chlorophyll a concentration

Tuna fishery field Chlorophyll  
distribute, HY-1A(**week average**)

The SST from HY-1A  
satellite in tuna field  
(2002.11.1-11.20)



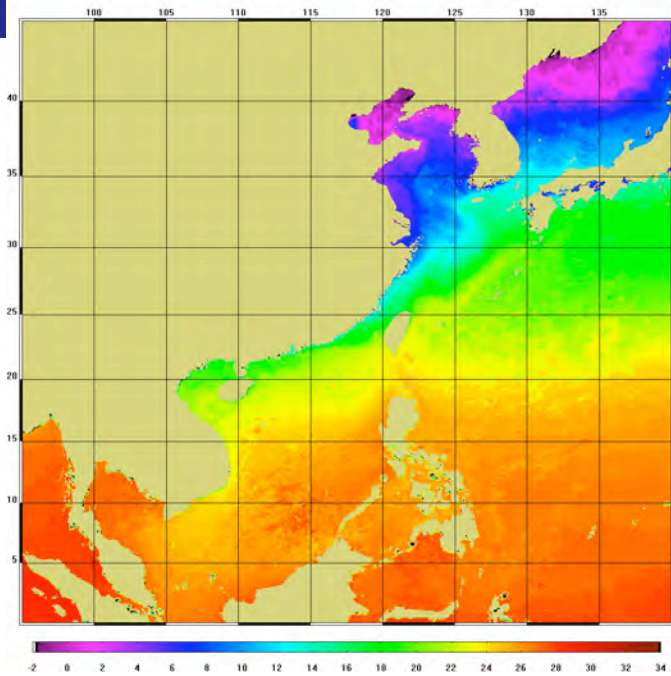
Sea surface temperature contour [2002.11.1-20]



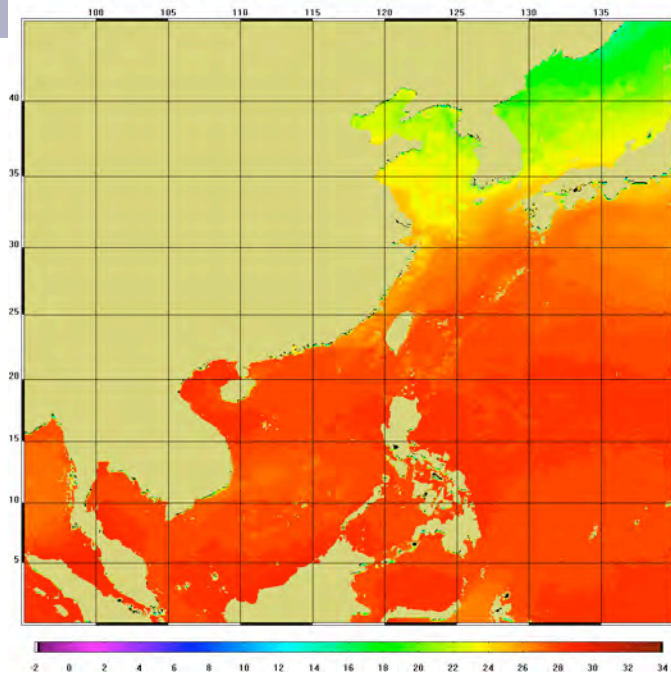
The SST contour map from HY-1A satellite in tuna field  
(2002.11.1-11.20)



1-3



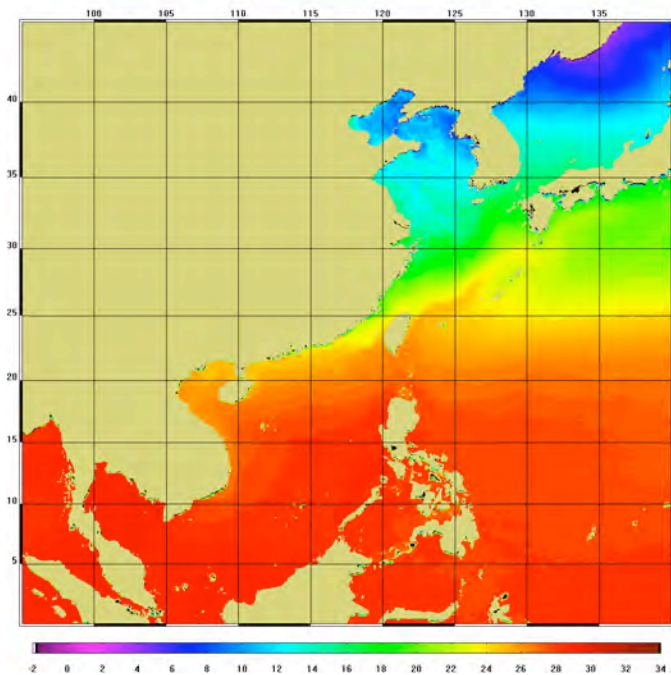
4-6



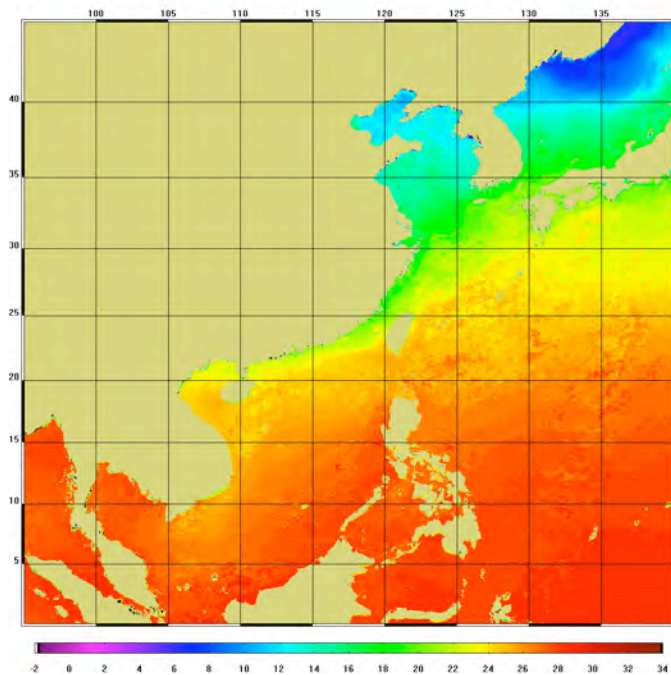
SST

Seasonal  
change

7-9



10-12



# Monitor the marine disaster

- Red-tide and pollution monitor

Red-tide





# Red tide

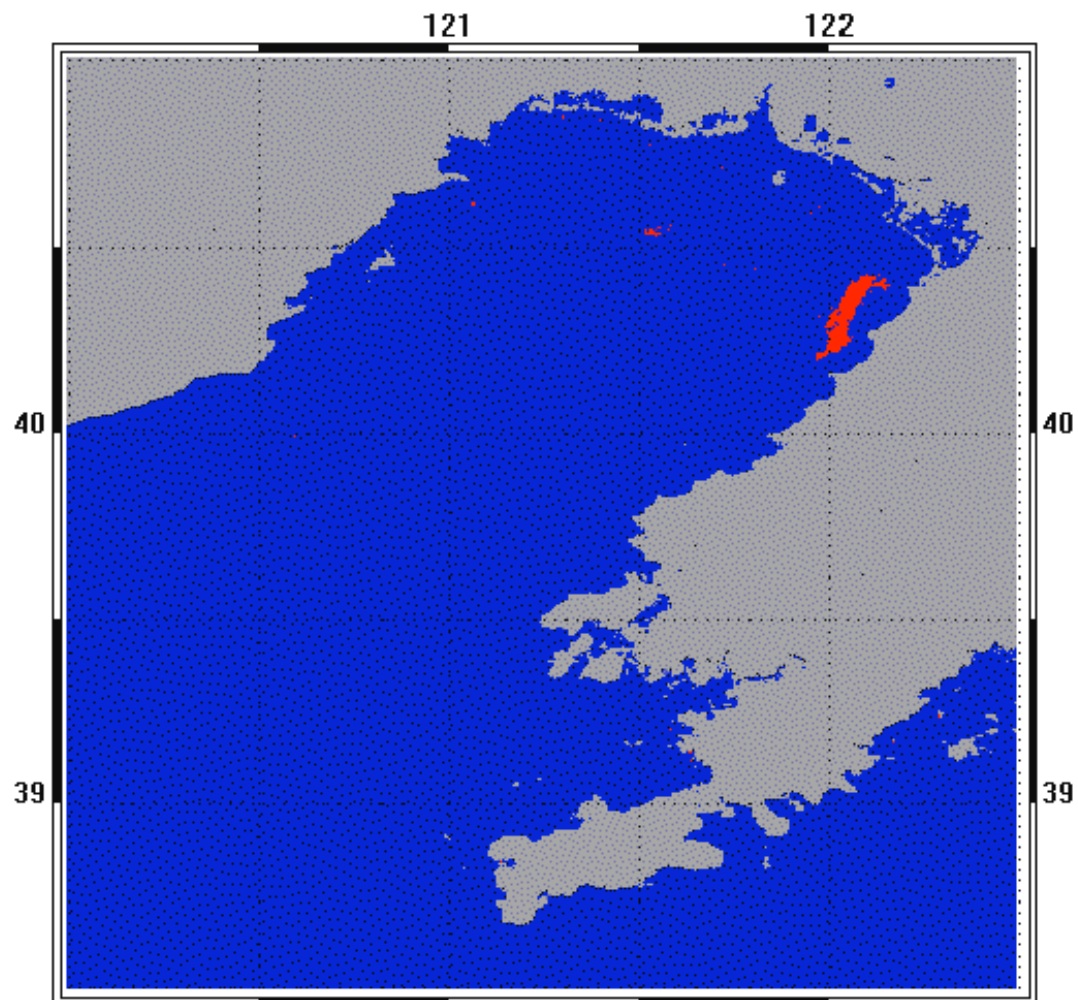
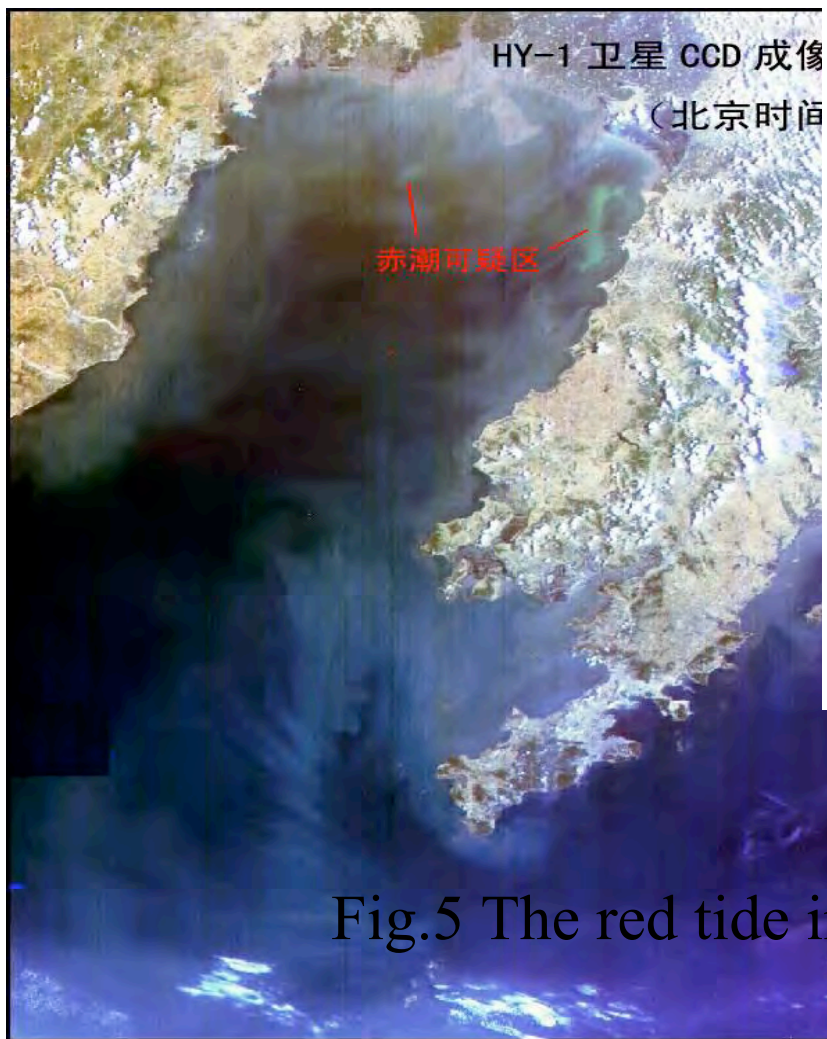
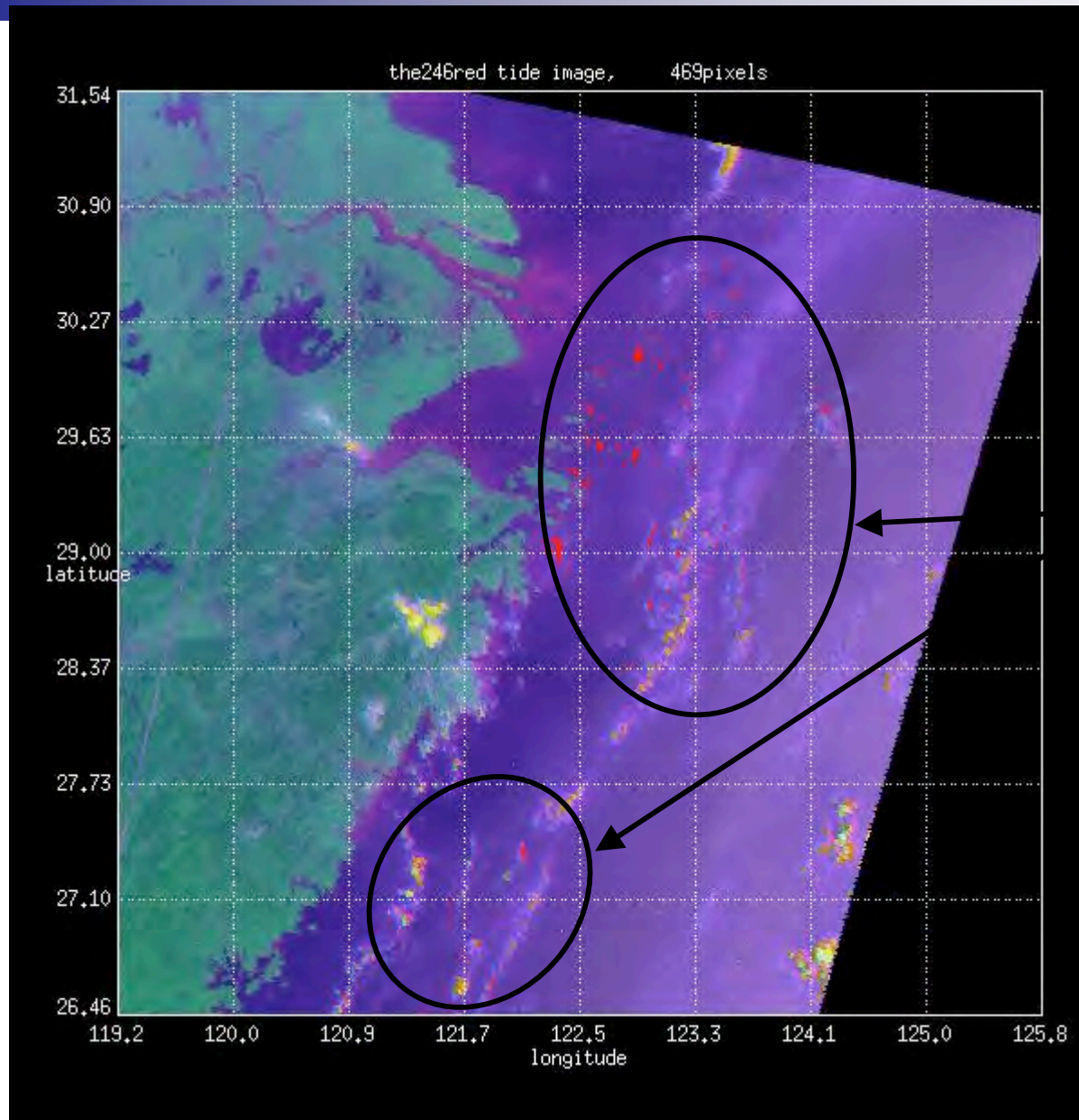


Fig.5 The red tide information monitor by HY-1/CCD  
in 15 Jun, 2002

国家卫星海洋应用中心

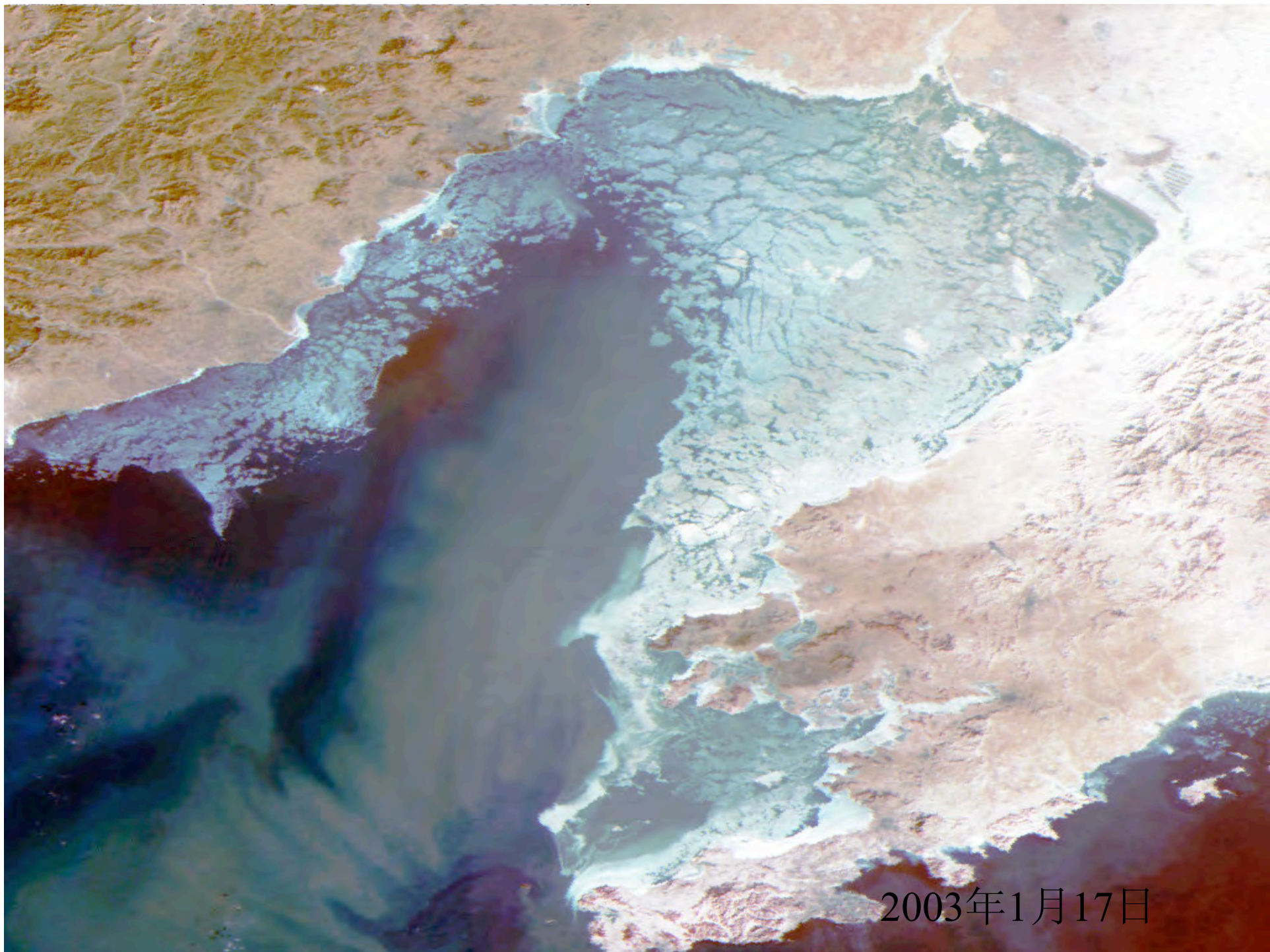
# Red-tide



2002年  
9月3日发  
现了东海  
海域赤潮

。







## 4 Other Application

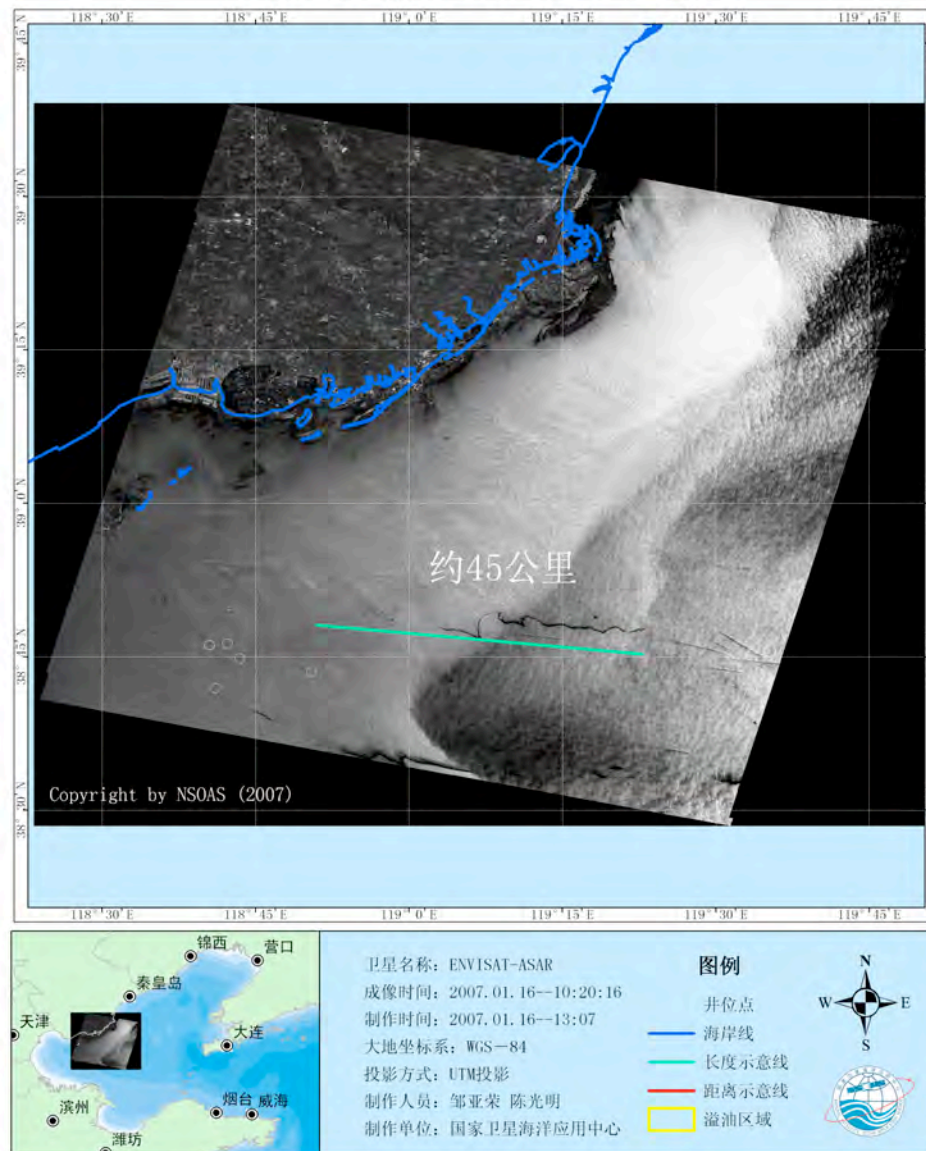
- Oil monitor by SAR, NDVI Vegetation general investigation using CZI, major lake water environment monitor, forest fire monitor and polar monitor.

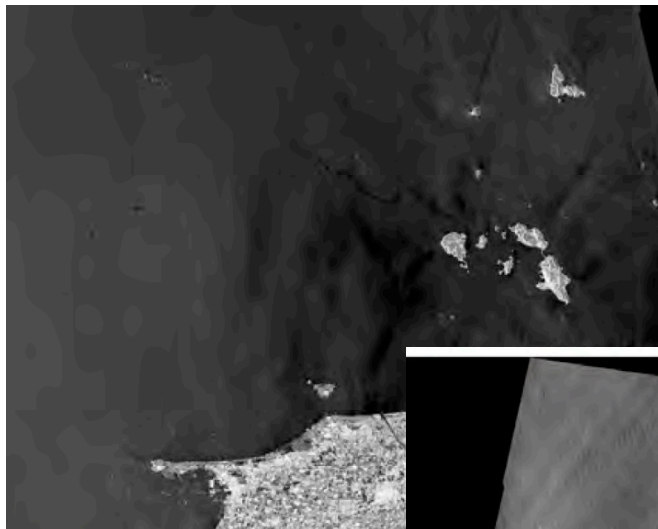


Oil spill, 2007-1-16  
45km  
Cao Feidian

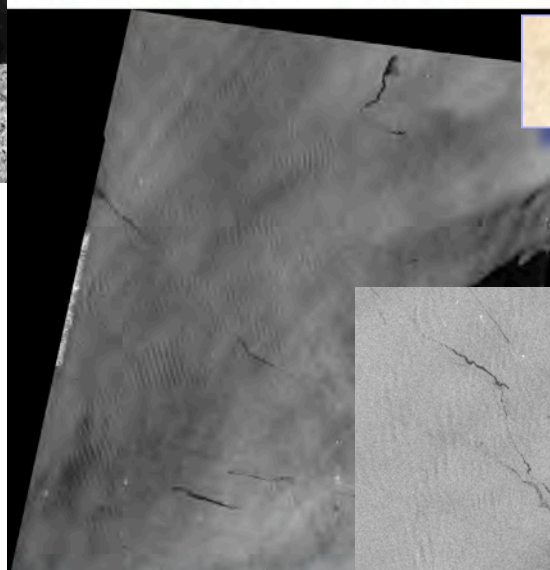
No. 2007006A

### 渤海溢油遥感监测解译图

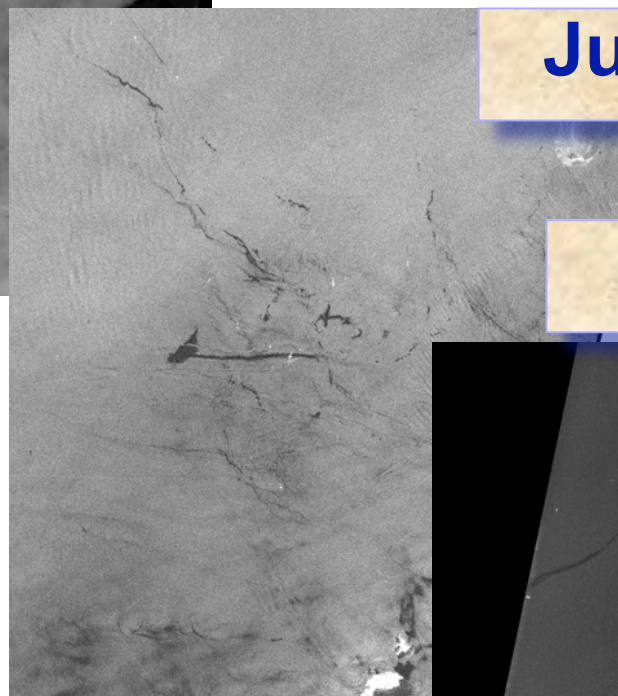




**May 10**



**May 24**



**June 13**

**July 14**

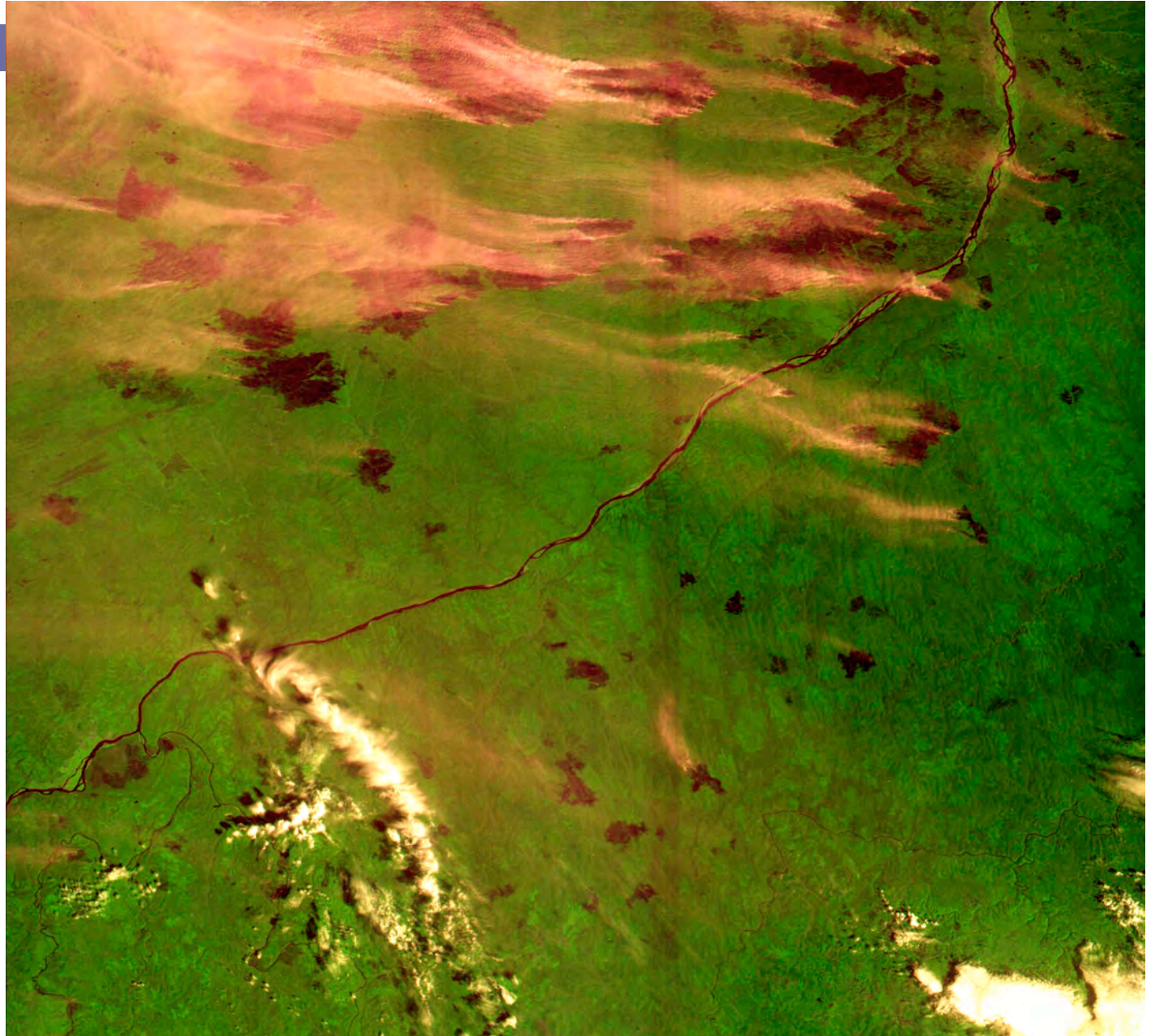


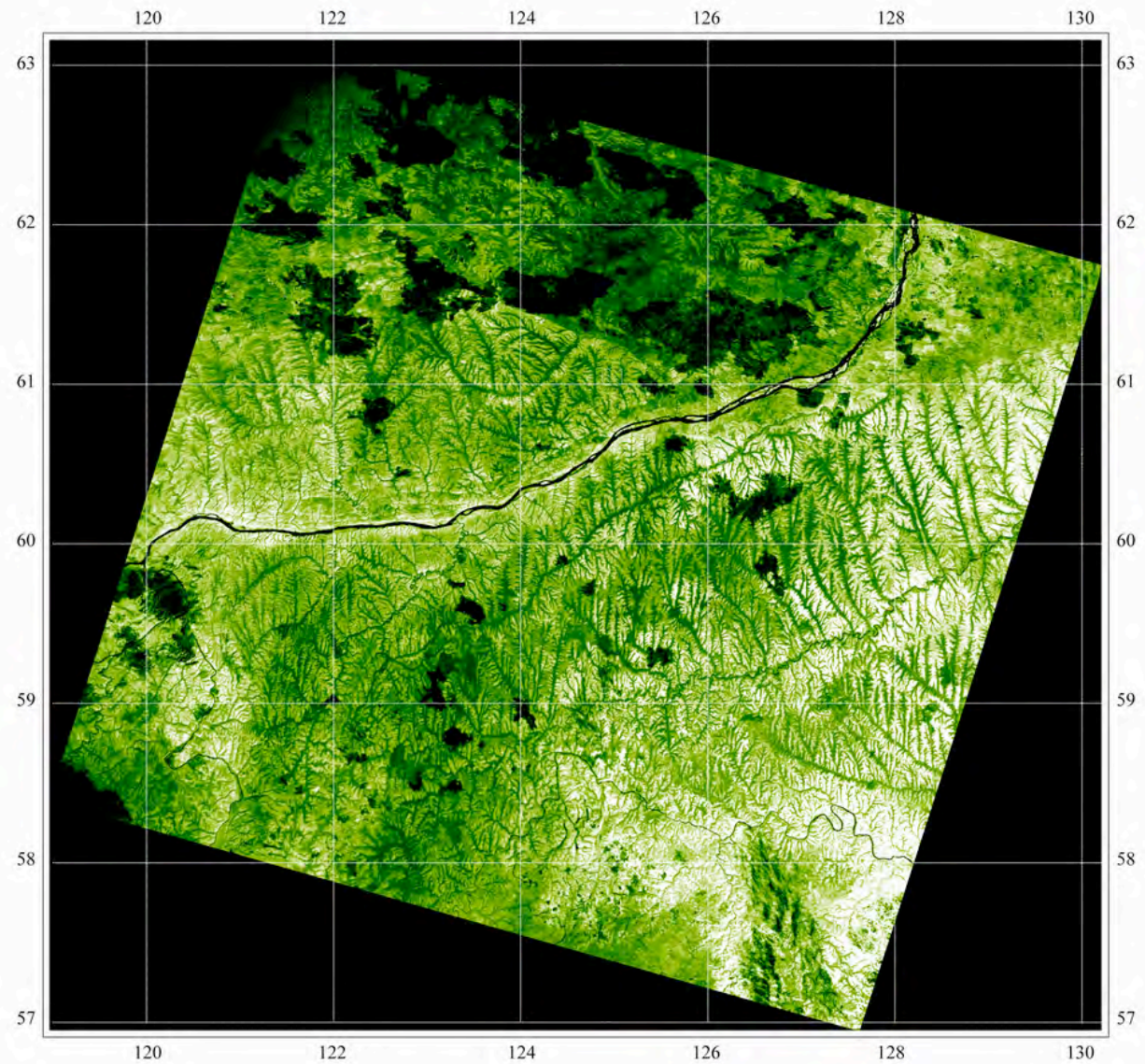




**HY-1A CZI**

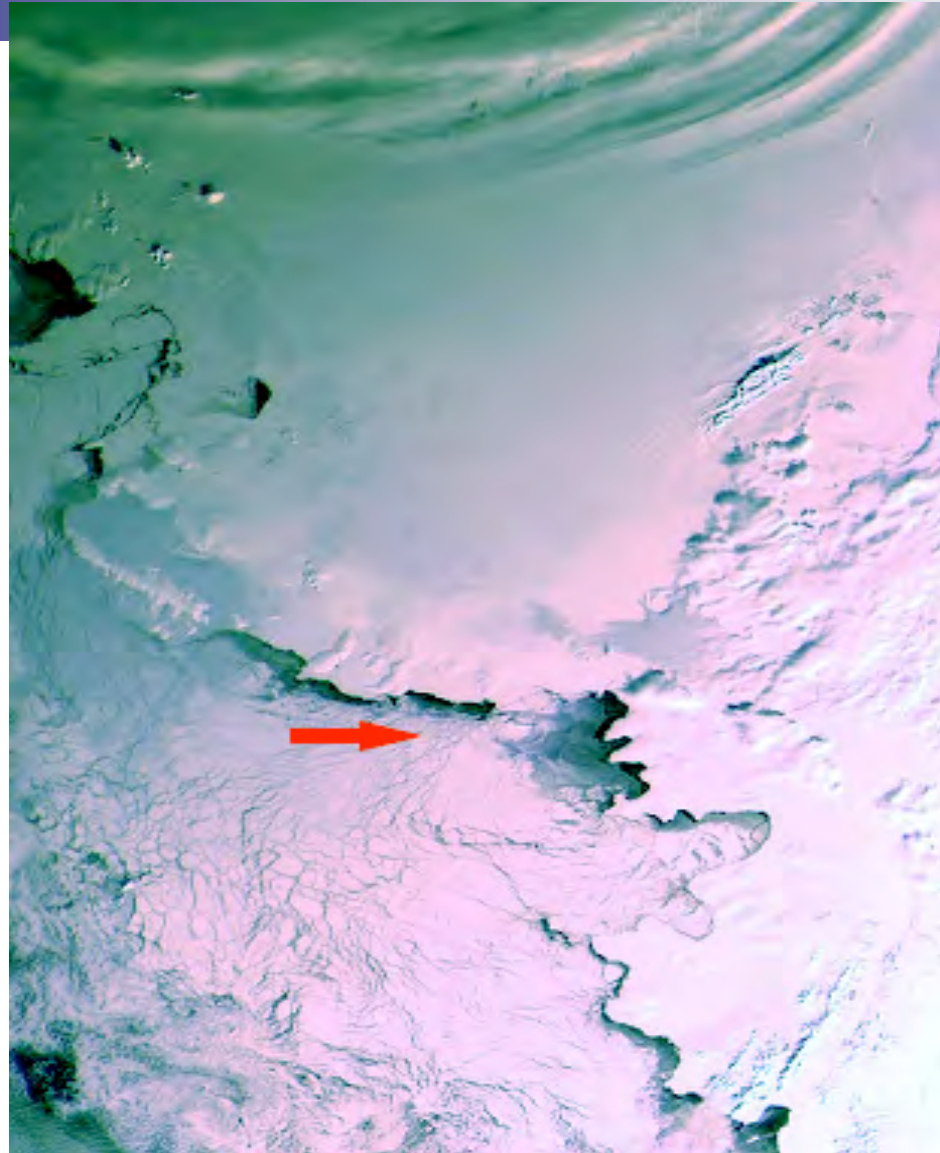
**Russia  
Lena River  
forest fire**



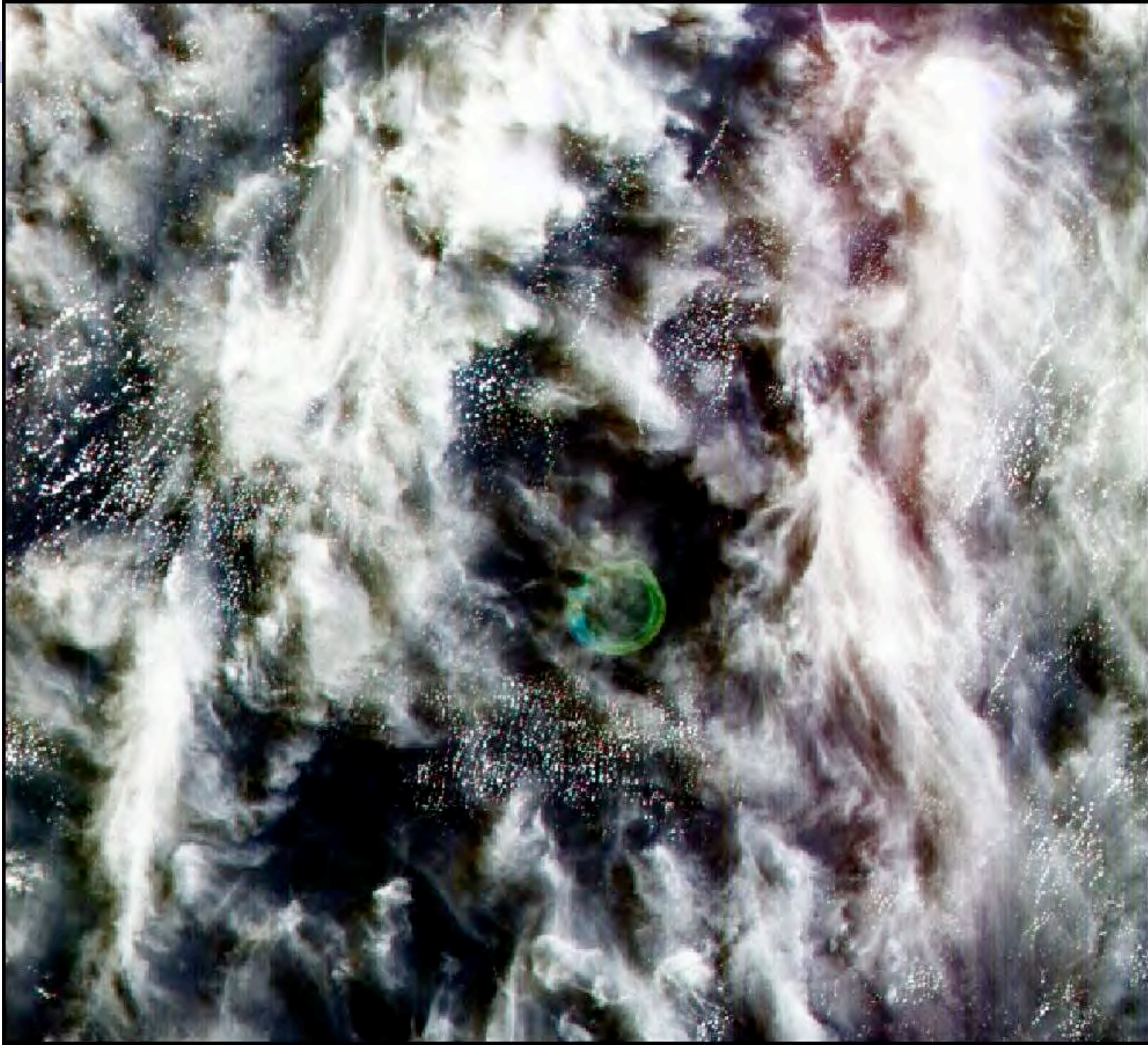


**The NDVI after the fired from HY-1A**





**The HY-1A COCTS south pole Icecap map in Oct,19,2002**

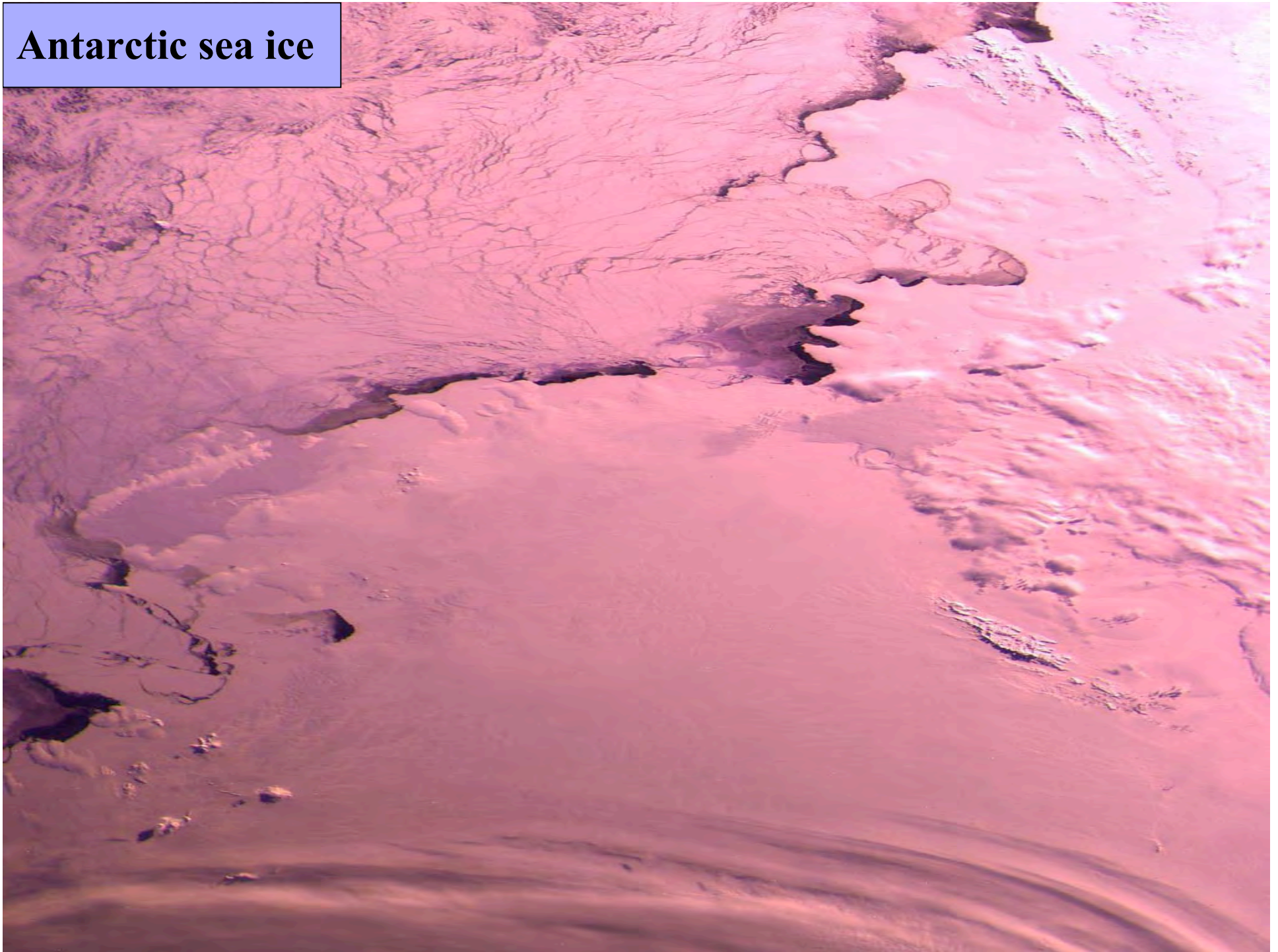


南海  
东沙珊瑚礁

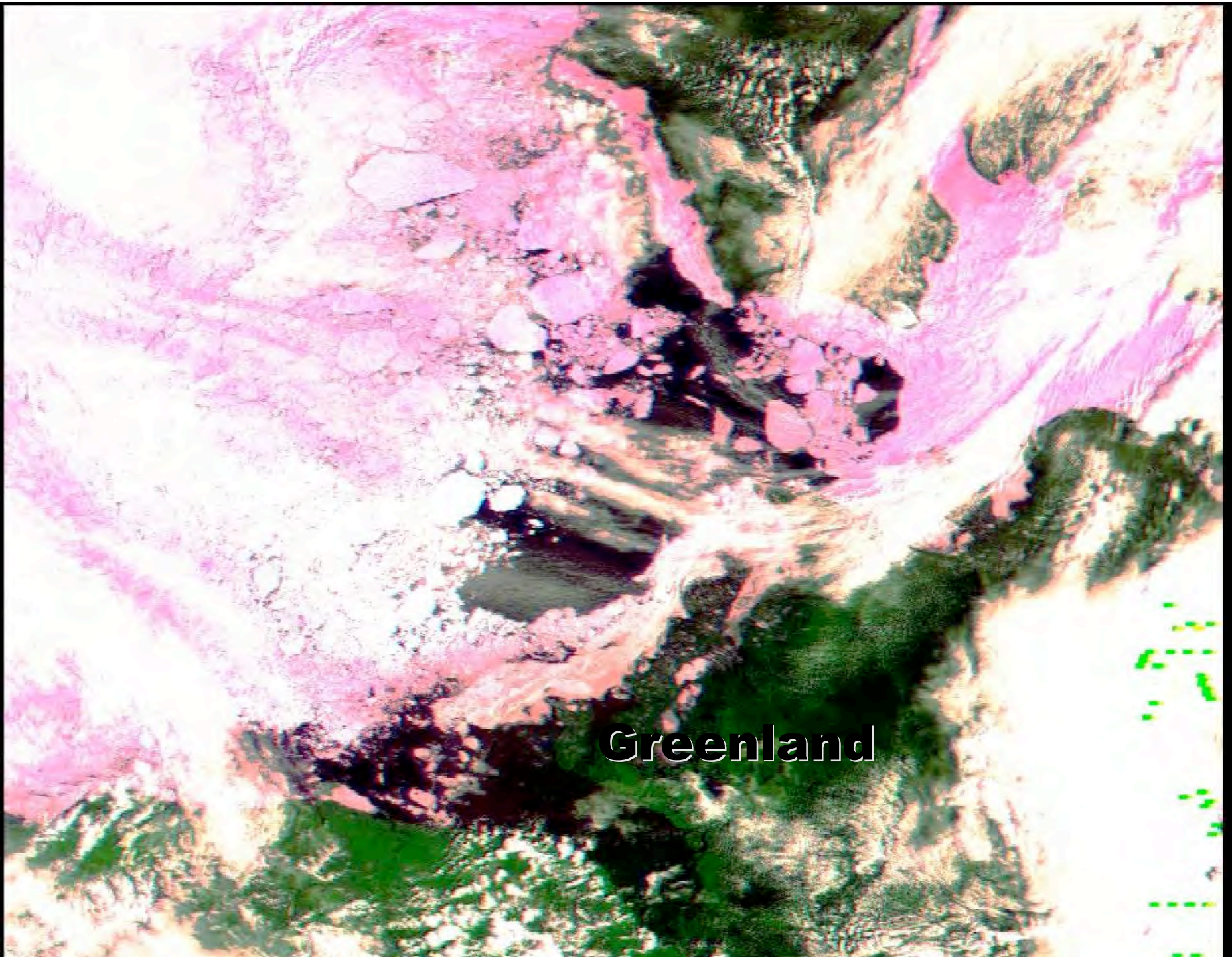
Coral  
Reef  
In South  
China  
Sea



## Antarctic sea ice



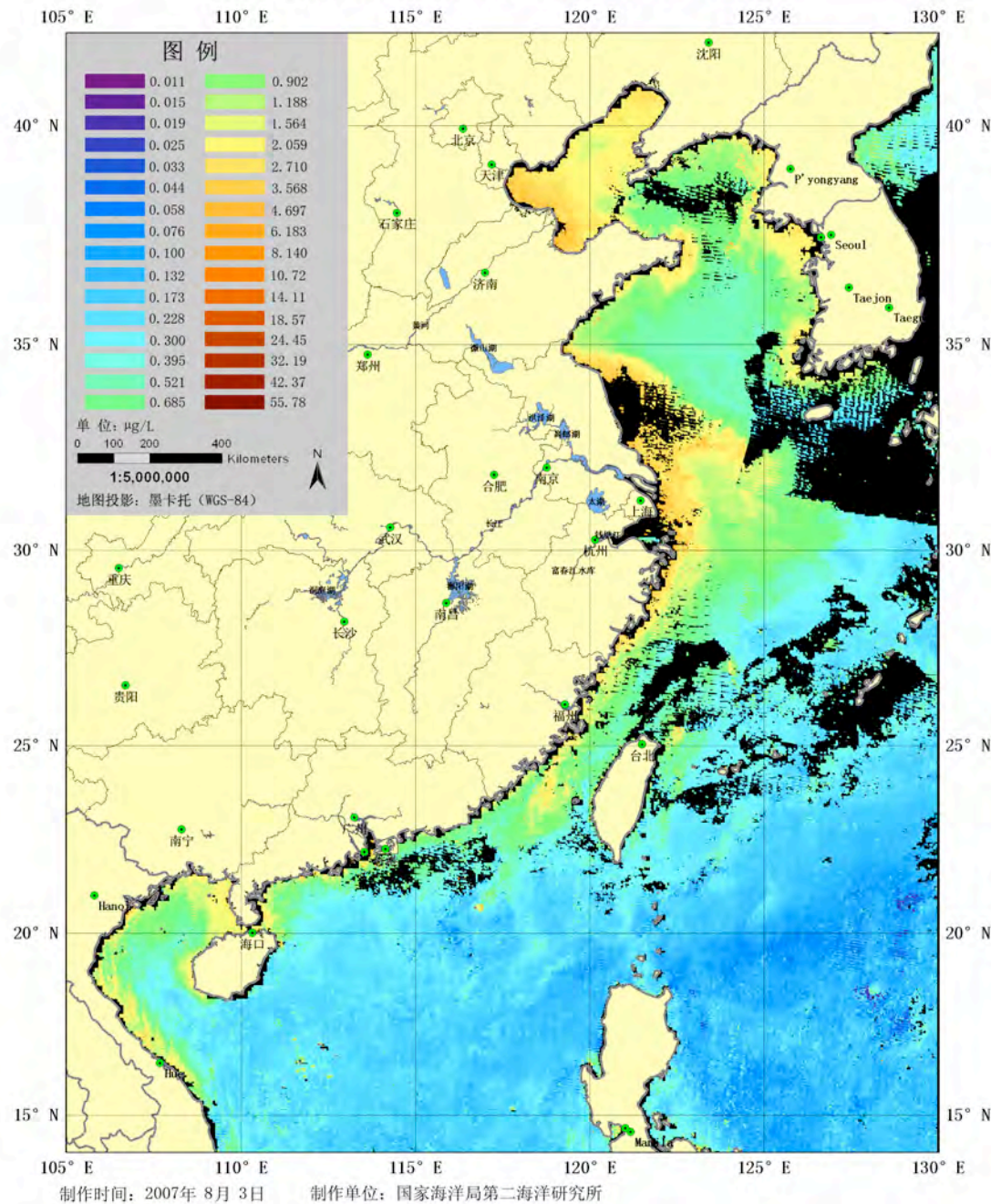




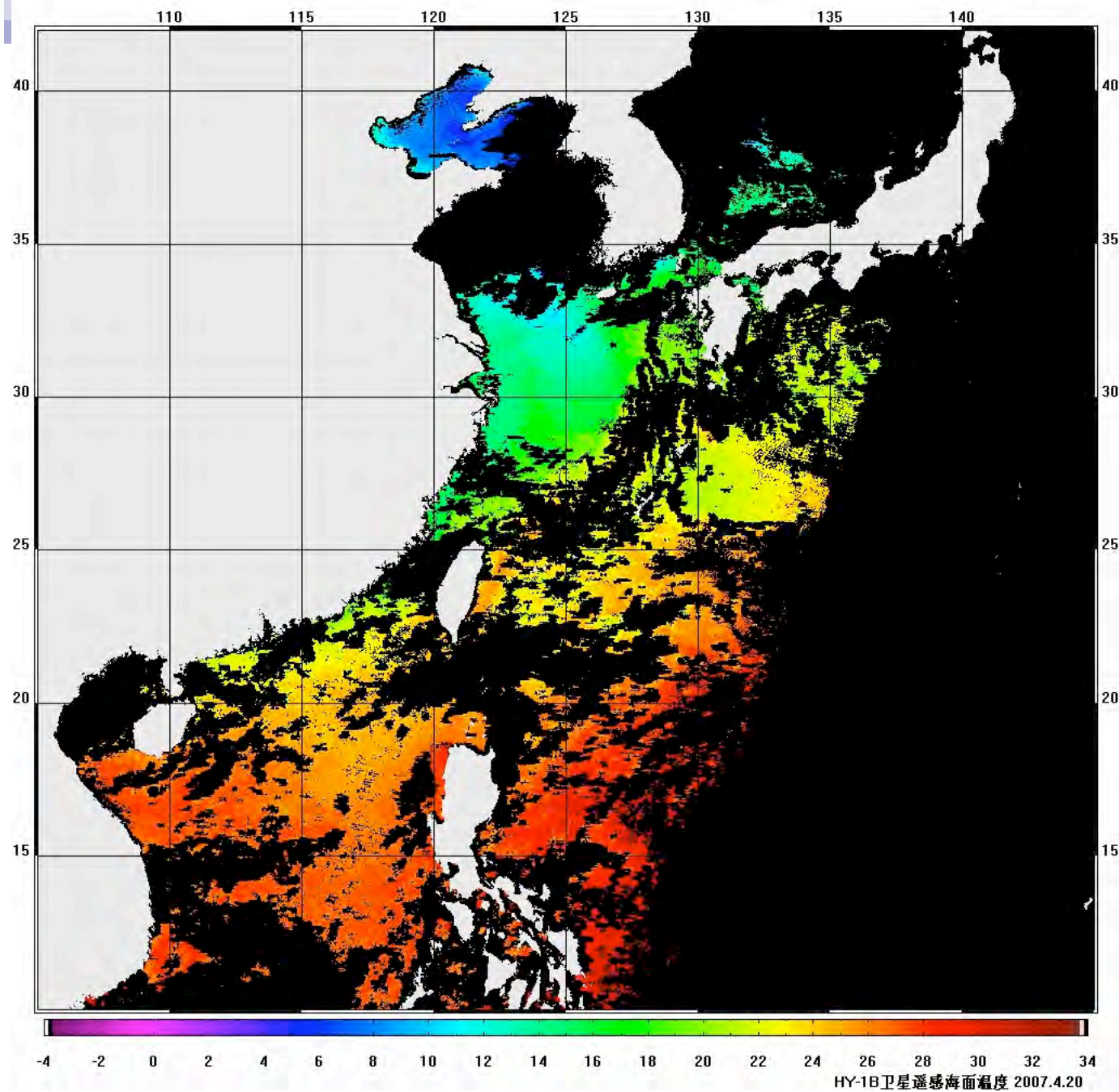


# HY-1B/COCTS卫星遥感水体叶绿素浓度专题图

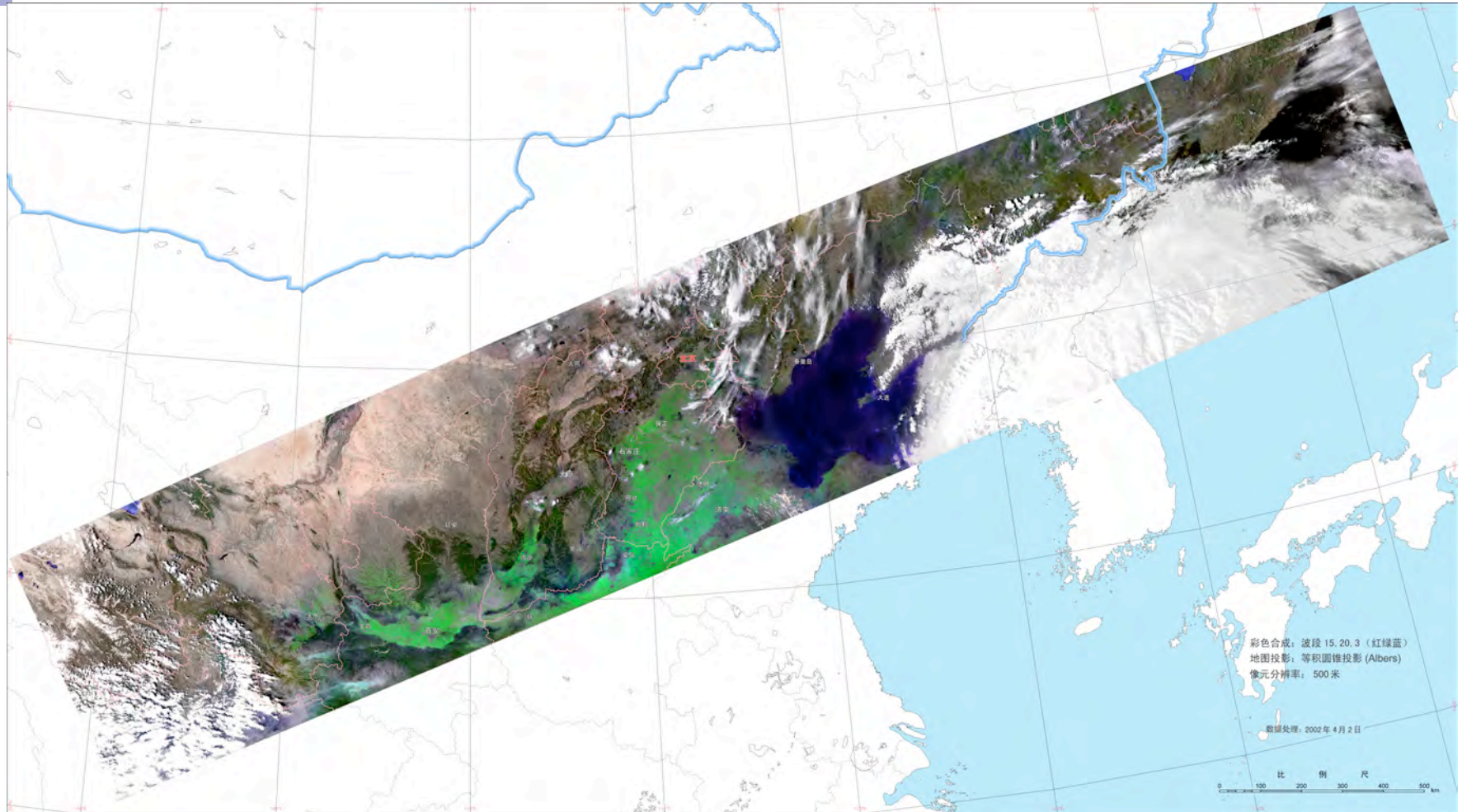
(资料时间: 2007年 5月 1日-2007年 5月31日)



The Monthly  
Average  
Chlorophyll  
from 1B/COCTS







CMODIS image

谢谢！

Thanko!