Second Institute of
Oceanography, SOA,PRC

New developments with Haiyang 1B (HY-1B) ocean color satellite

(Report to 13th IOCCG)

Pan Delu

Second Institute of Oceanography, SOA, PRC

New developments with Haiyang 1B (HY-1B) ocean color satellite

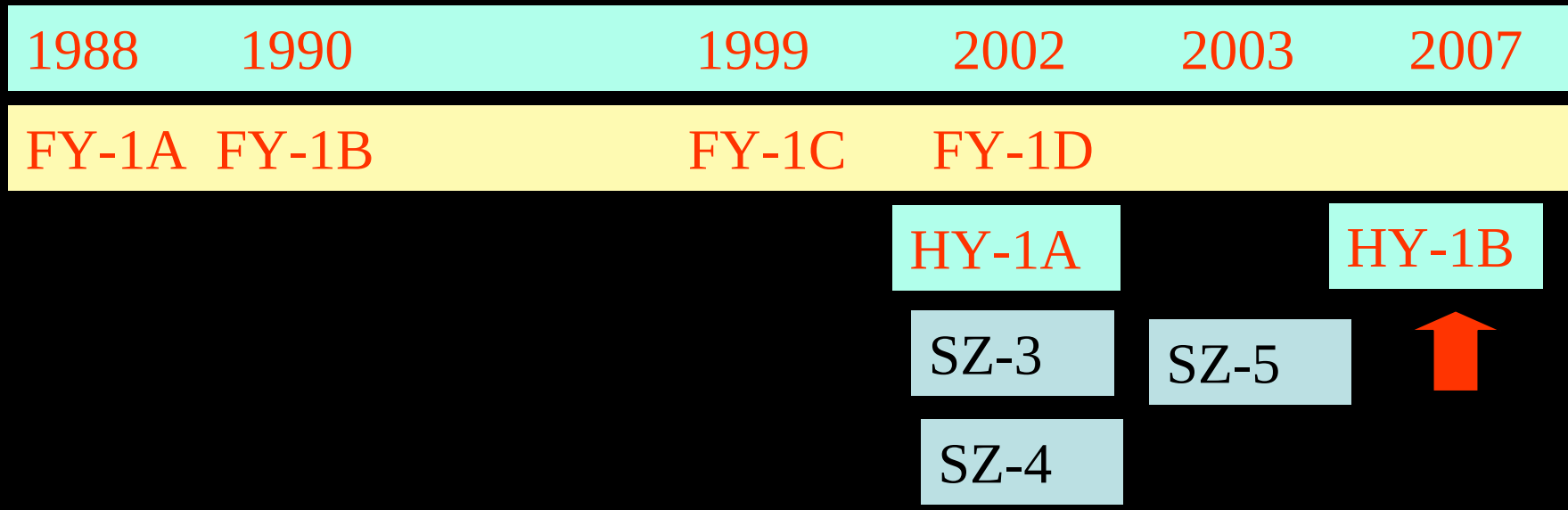
1、Chinese satellite HY-1B in 2007

2、Calibration and validation

3 、 Application

Chinese Ocean color satellite HY-1B is on orbit since April. 2007

中国海洋　星的　展Satellite programs for marine remote sensing in China



HY-1B Oceanic Satellite

Second ocean color satellite of China, HY-1B was launched by Long March rocket, in 11,April, 2007.

Sponsored by State Oceanic Administration, (SOA), Manufactured by the Chinese Academy of Space Technology (CAST)

HY-1B *Satellite and orbit characteristics*

Orbit type	*Near Circular and near sun-synchronous*
Equator crossing local time	*10:30-11:30am (descending node)*
Altitude	*798km*
Inclination	*98.8 deg*
Period	*100.8 minute*
Repeat observation period	*1days for COCTS, 7days for CZI*
Mass	*350kg*
Payload	*COCTS and CZI*
Attitude control	*3 axis stabilized*
Downlink frequency	*X-band*
TT&C link	*S-band*
Designed life time	*3 years*
Launch	*April,11,2007 by using Long March 4*
Manufacturer	*CAST*

HY-1B Payload

1. COCTS- Chinese Ocean Color and Temperature Scanner

by SITP

2. CZI- Coastal Zone Imager

(CCD Cameral) by CAST

The properties of HY-1 with comparing the other ocean color satellites

Nation/area	USA	PRC	Japan	PRC	PRC	PRC	Taiwan China	Europe	USA
Sat./Sensor	CZCS/ Nimbus	VHRSR/ FY-1A/B	OCTS/ ADIOS	VHRSR/ FY-1C	COCTS HY-1A/B	ICZ HY-1 A/B	OCI/ ROCSAT1	Envisat MERIS	SeaWiFS/ SeaSTAR
Life (year)	1978-88	1990-91	1996-97.6	1999-	2002/2007-	2002/2007-	1998-	2002-	1997-
FOV (^{0})	78.68	110.8	80.0	110.8			60	68.5	116.6
Period (mun)	104.07	102.76	100.8	102.76	100.8	100.8	96.6		98.88
Inclin. (^{0})	99.28	98.9	98.6	98.9	98.8	98.8	35	98.55	98.2
Scan.Rate (s)	0.12375	1/6	1.0	1/6	1/6	1/6	1/9		1/6
Alti. (KM)	955	888.8	791	870	798	798	600	800	705
Flight dir.	ascend.	Descend.	descend.	descend.	descend.	descend.		descend.	descend.
ECT	11:00am	7:55am	10:30am	9:00 am	10:00 am	10:00 am	9:00-15:00	10:00 am	12:00noon
Pixels/Line	1968	2048	2222	2048	1024	2048	860	2241	1285
Tilt (^{0})	0^0,± 20^0	0^0	0^0,± 20^0	0^0	0^0	0^0	0^0	0^0	0^0,± 20^0
Digitization	8bit	8 bit	10 bit	10 bit	10 bit	10 bit	10 bit	16 bit	10 bit
Channel	± 10nm	(μ)	± 10nm	(nm)	± 10 nm	(nm)	(nm)	± 10nm	± 10nm
1	440	0.58-0.60	412	0.43-0.48	410	HY-1A	433-453	412.5	412
2	520	0.725-11.0	443	0.48-0.53	443	420-500	480-500	442.5	443
3	560	0.48-0.53	490	0.53-0.58	490	520-600	500-520	490	490
4	670	0.53-0.58	520	0.58-0.68	520	610-690	545-565	510	510
5	0.7-0.8u	10.5-12.5	565	0.84-0.89	565	760-890	660-680	560	555
6	10.5-12.5		665	0.9-0.965	670		845-855	620	670
7			765±20	1.58-1.64μ	(A:730 -770)	HY-1B		665	765± 20
8			865±20	3.55-3.93μ	(B:740-760)	433-455		681.25±7.5	865± 20
9			3.7 μ	10.3-11.3μ	845-885	555-575		708.75	
10			8.5 μ	11.5-12.5μ	10.3-11.4μ	655-675		753.75±7.5	
11			11 μ		11.4-12.5μ	675-695		760.62±3.7	
12			12 μ					778.75±15	
13								865±20	
14								885	
15								900	

Major parameters of COCTS and CZI

Parameter	COCTS	CZI
Spatial resolution	1.1km	0.25km
Scan coverage	1400km/1664	500km/2048
Polarization sensitivity	5%	5%
Digitization	10bit/pixel	12bit/pixel
Data transmission rate	2.6616Mbps	2.6616Mbps
Radiometer	10%	10%

HY-1B/COCTS bands and detection object

Wave band(μm)	Target
0.402~0.422	Yellow substance, water pollution
0.433~0.453	Absorption of chlorophyll
0.480~0.500	Chlorophyll, sea water optics sea ice Pollutants, shallow sea topography
0.510~0.530	Chlorophyll, water depth, Sediment of low concentration
0.555~0.575	Chlorophyll, Sediment of low concentration
0.660~0.680	Peak of fluorescence, Sediment of high concentration, pollution, atmospheric correction, aerosols
0.740~0.760	Sediment of high concentration, atmospheric correction
0.845~0.880	atmospheric correction, water vapor
10.3~11.4	SST, sea ice, temperature of cloud top
11.4~12.5	SST, sea ice, temperature of cloud top

HY-1B/CZI bands and detection object

Wave band(μm)	Target
0.433~0.453	pollution, vegetation, ocean, color ice, shallow sea topography
0.555~0.575	Sediment, pollution, vegetation ice , coast zone
0.655~0.675	Sediment, soil ,water vapor
0.675~0.695	soil ,water vapor , atmospheric correction

HY-1B Ground Station Location

Beijing

青岛

Hangzhou

SanYa

三亚

HY-1B SATELLITE GROUND STATION

(1)Beijing (NSOAS/SOA)

Receive raw data in real time acquiring, processing, archiving and managing, distributing and analyzing the HY-1 mission

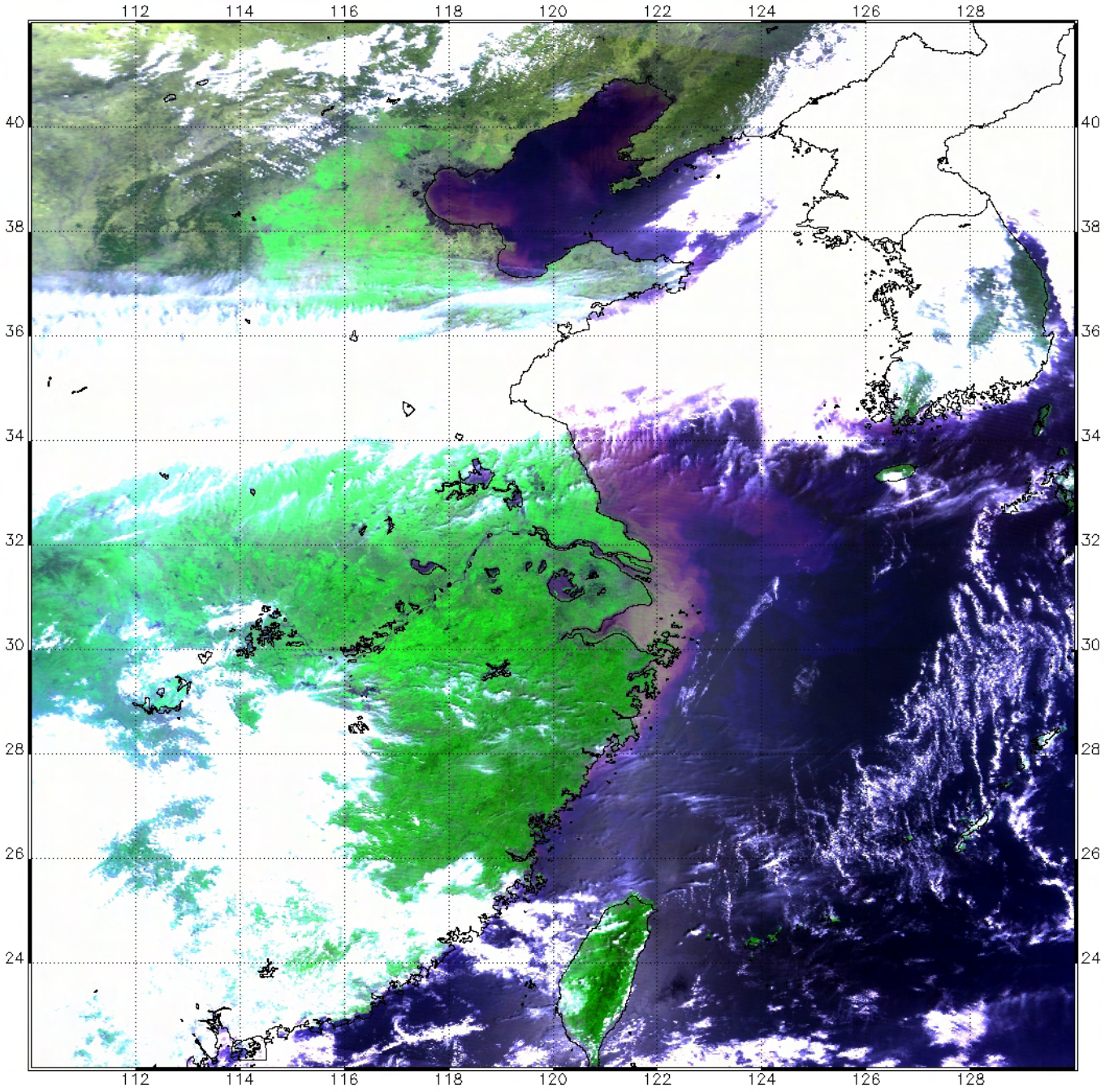
(2)Hangzhou (SIO/SOA)

Receive raw data in real time acquiring, processing, archiving and managing, applying and analyzing the HY-1 mission

(3) SanYa

Receive raw data in real time and transfer to Beijing

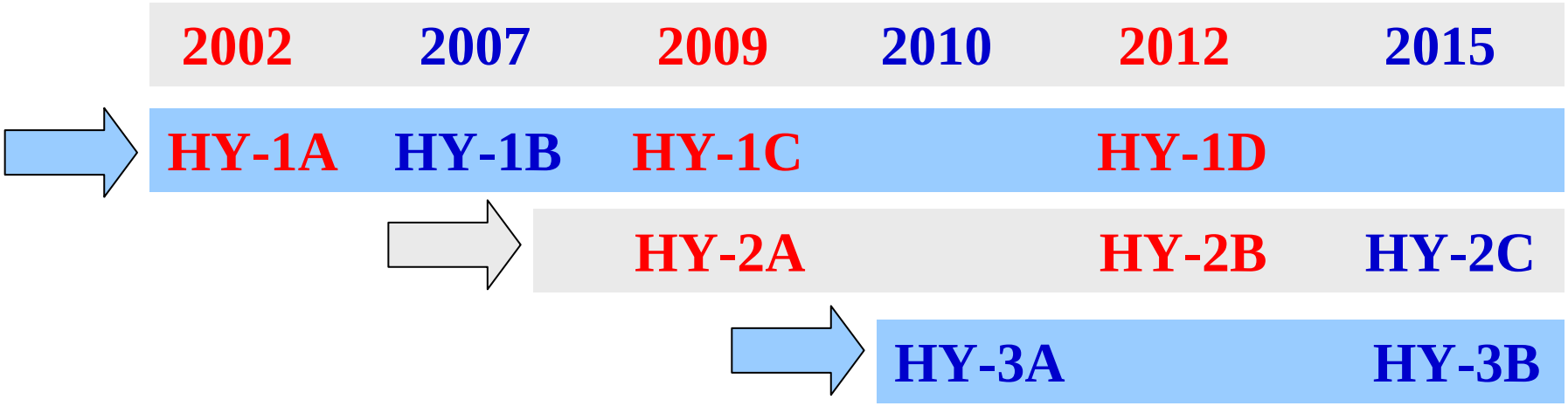
4) Mudanjiang just being build.



HY-1B
20 April
First
COCTS Image

HY-1B
20 April
First
CZI Image

Chinese Ocean Satellite programs in next 10 years



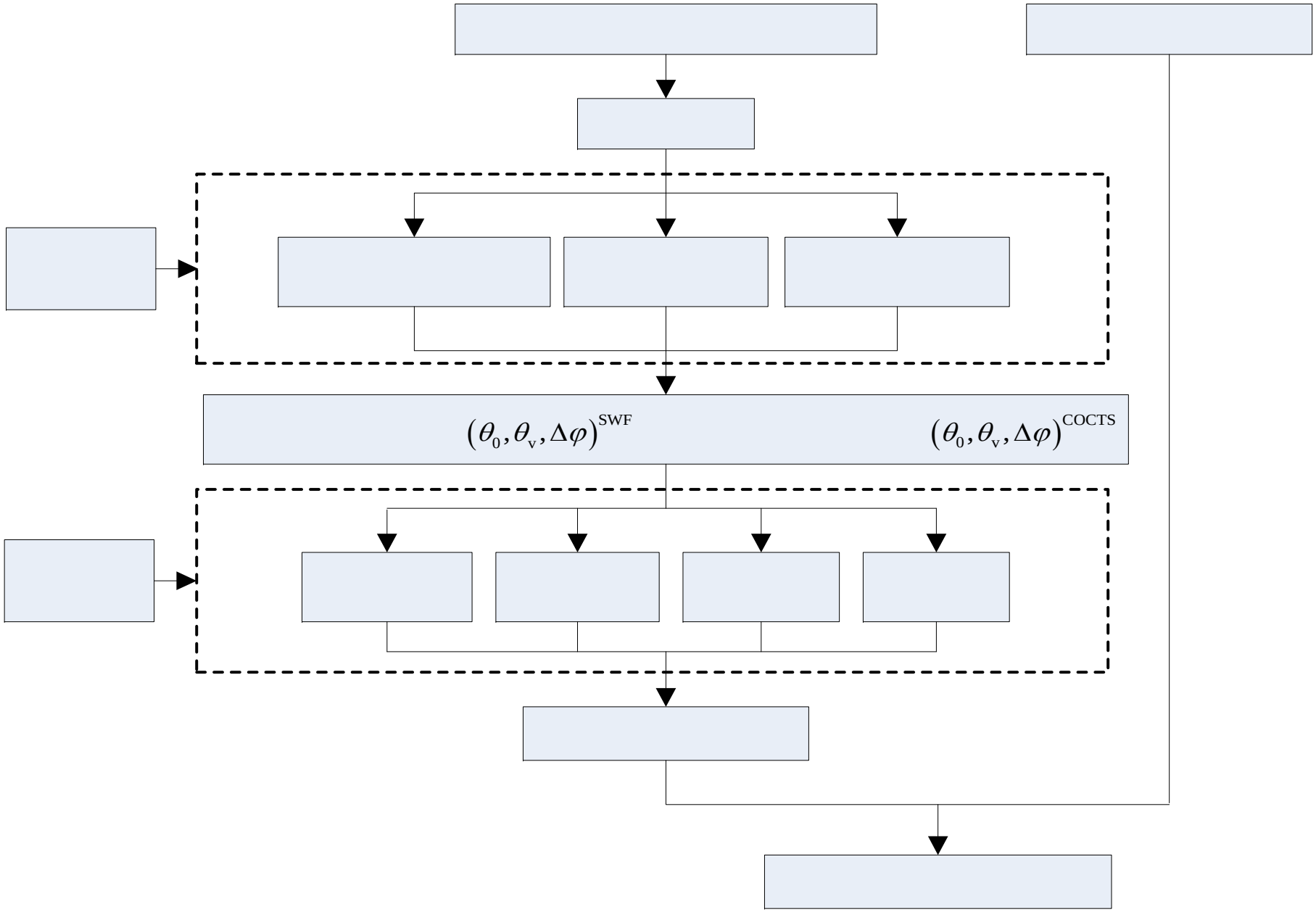
New developments with Haiyang 1B (HY-1B) ocean color satellite

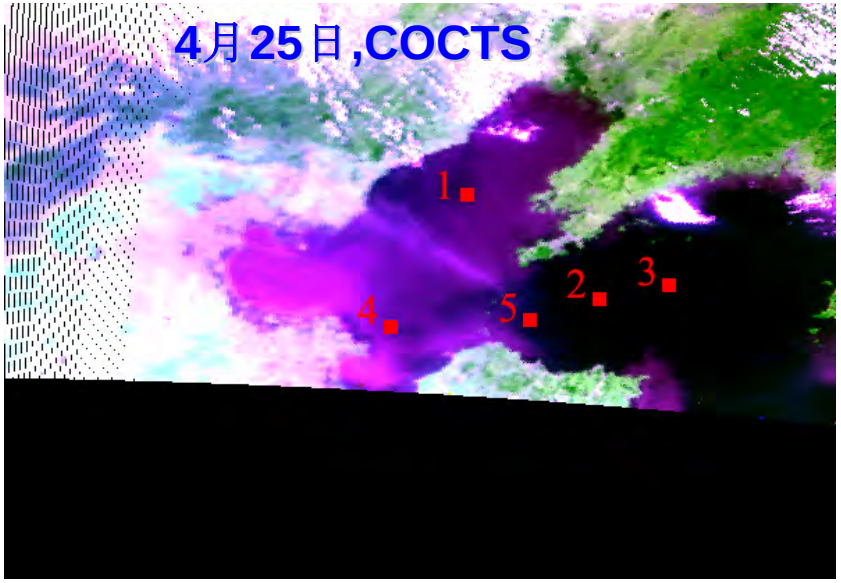
1、Chinese satellite HY-1B in 2007

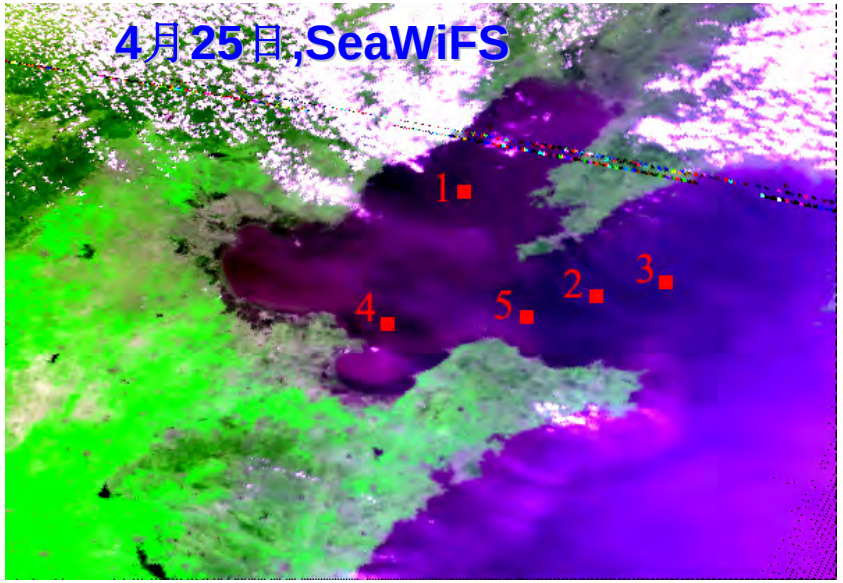
2、Calibration and validation

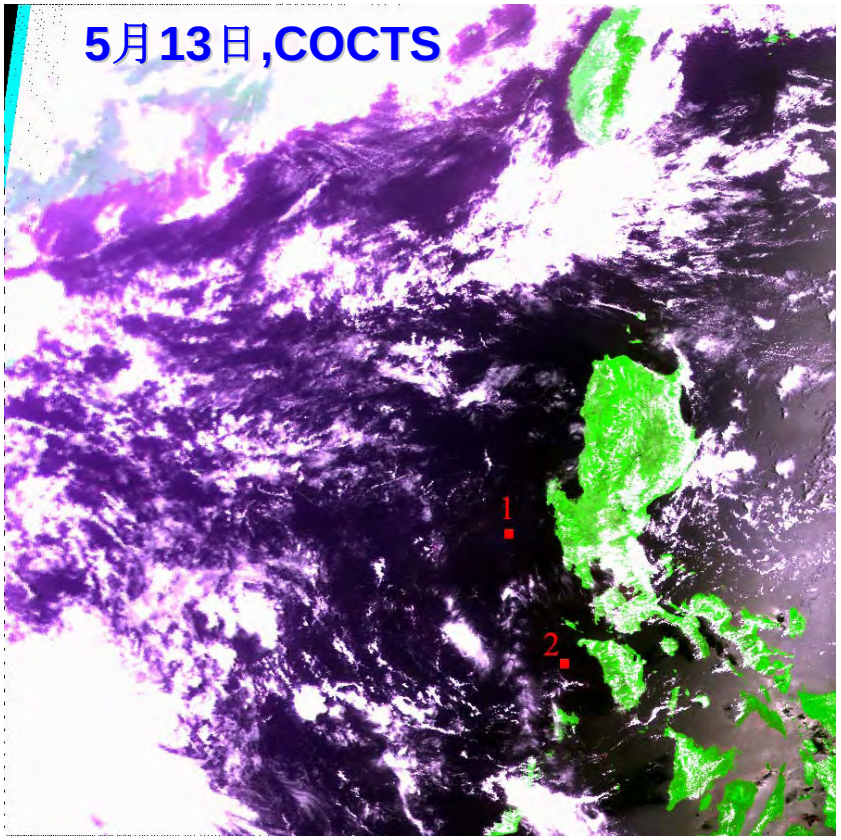
3 、 Application

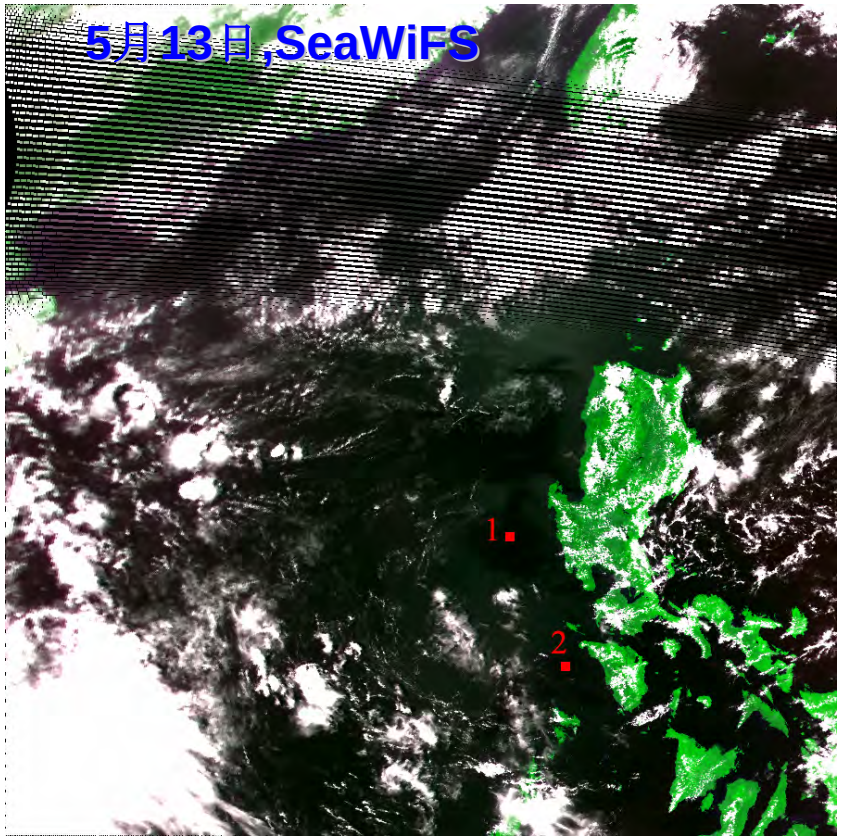
Satellite cross calibration SeaWiFS/COCTS

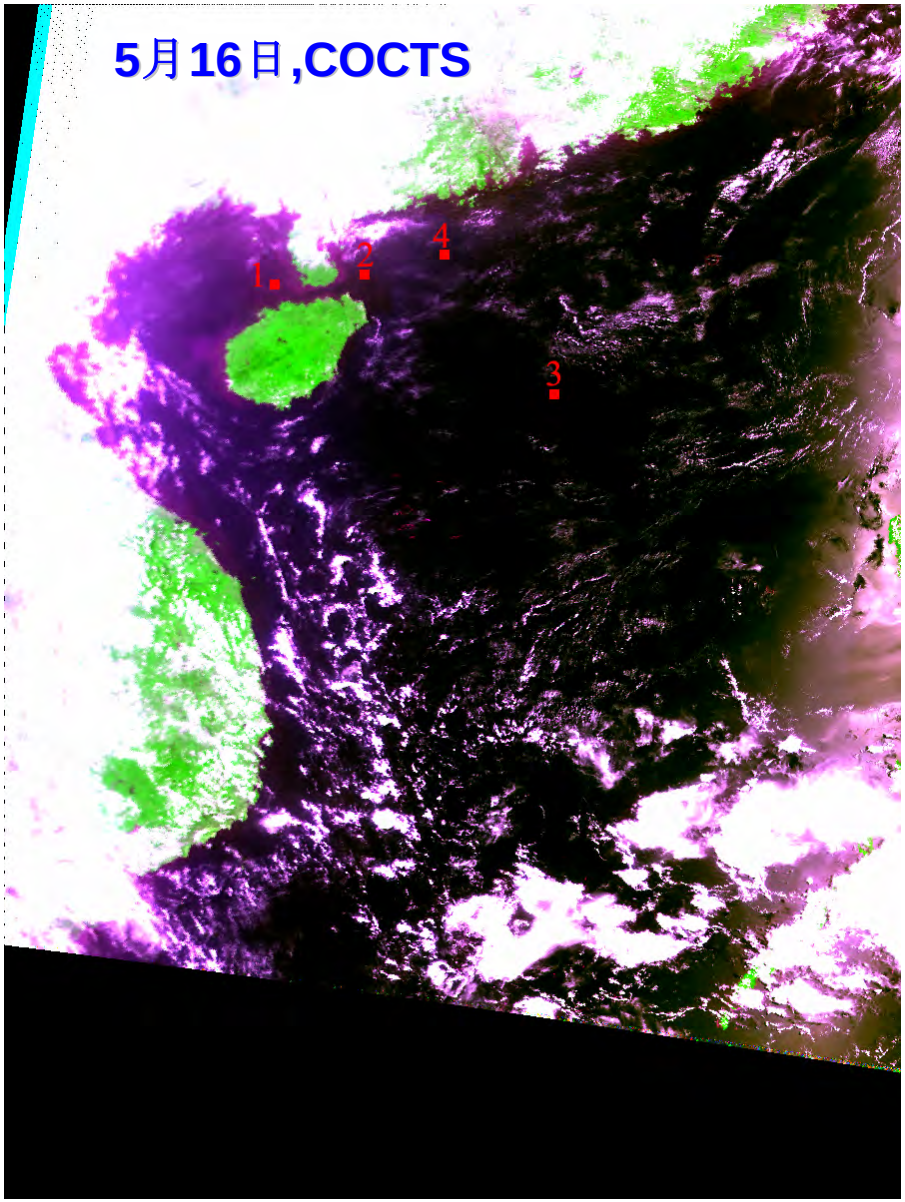


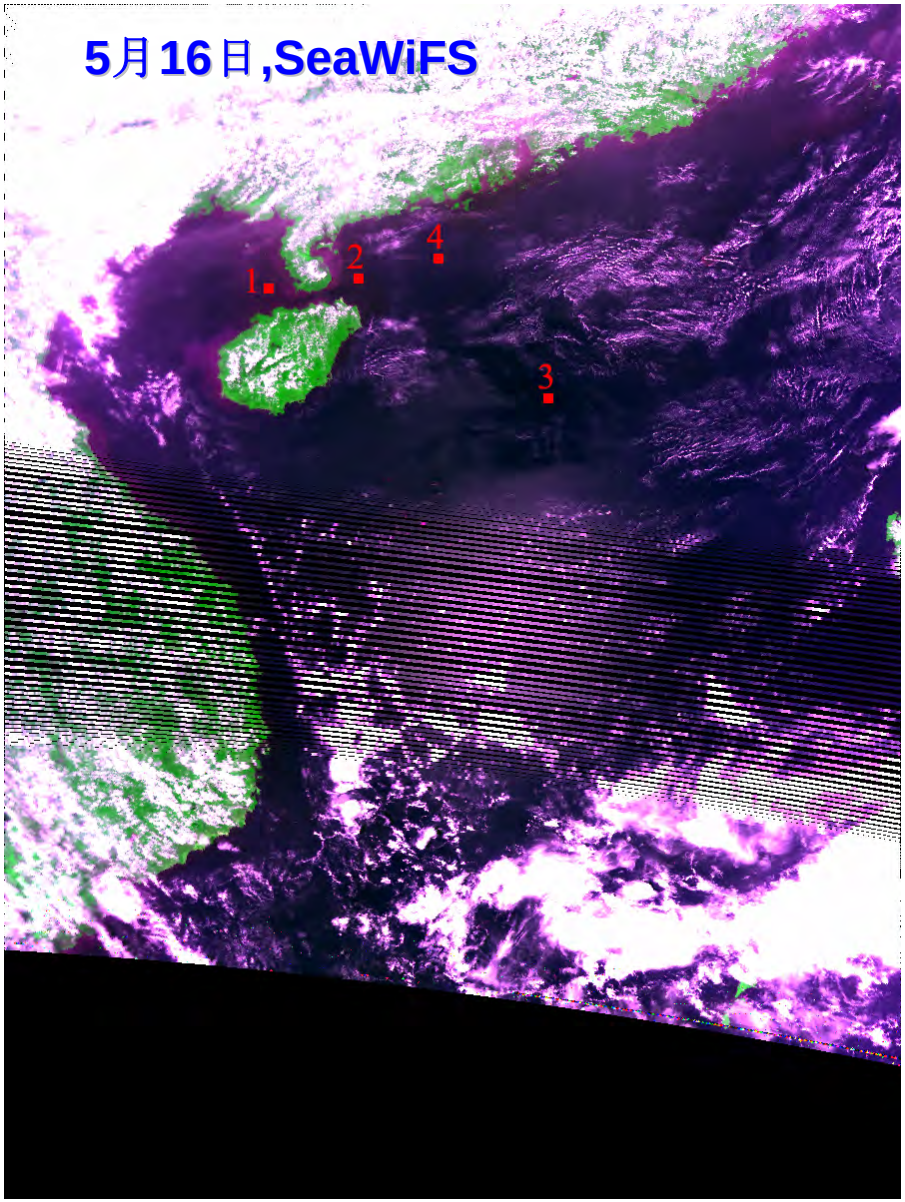

4月25日,COCTS
1
2
3
4
5

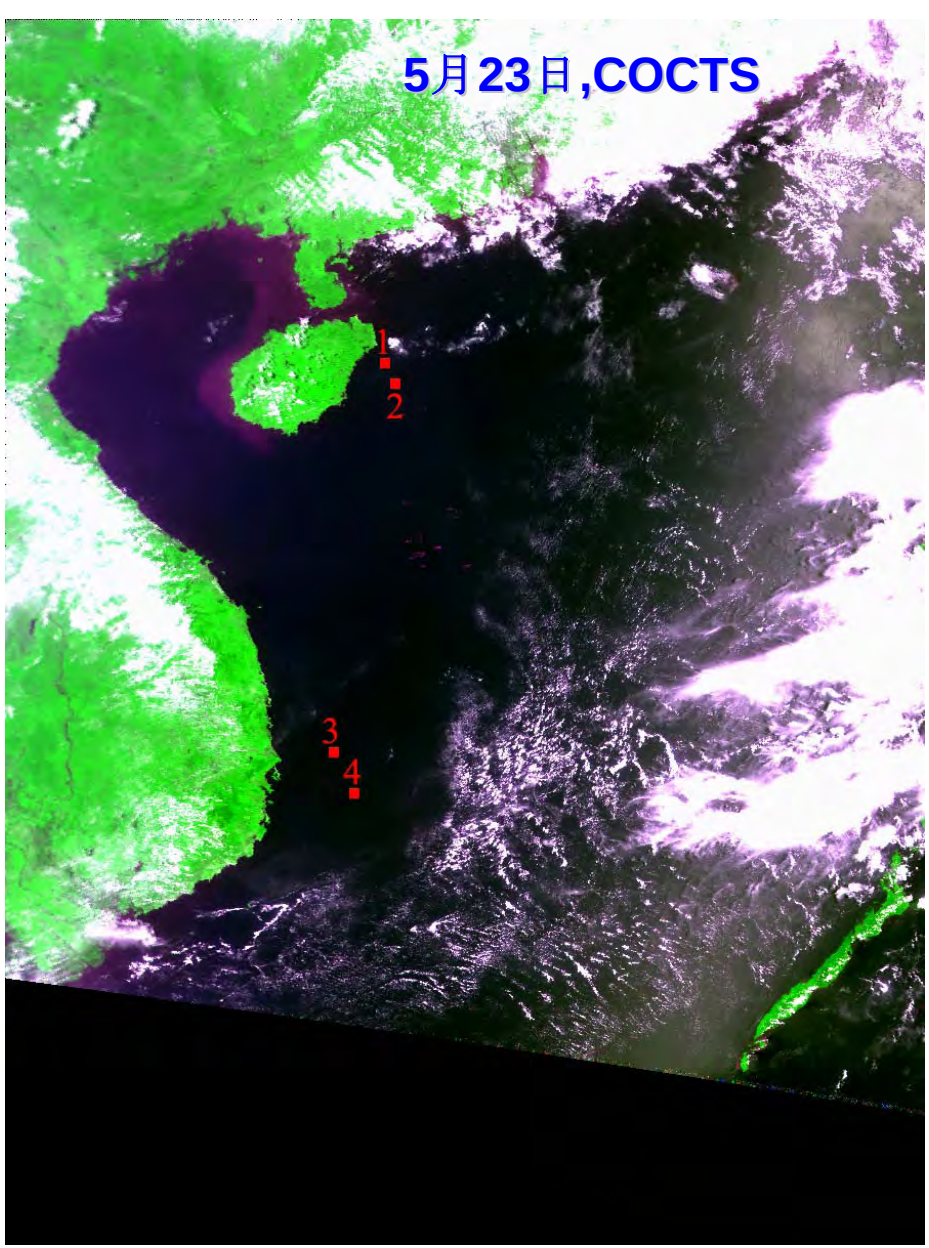

4月25日,SeaWiFS
1
2
3
4
5

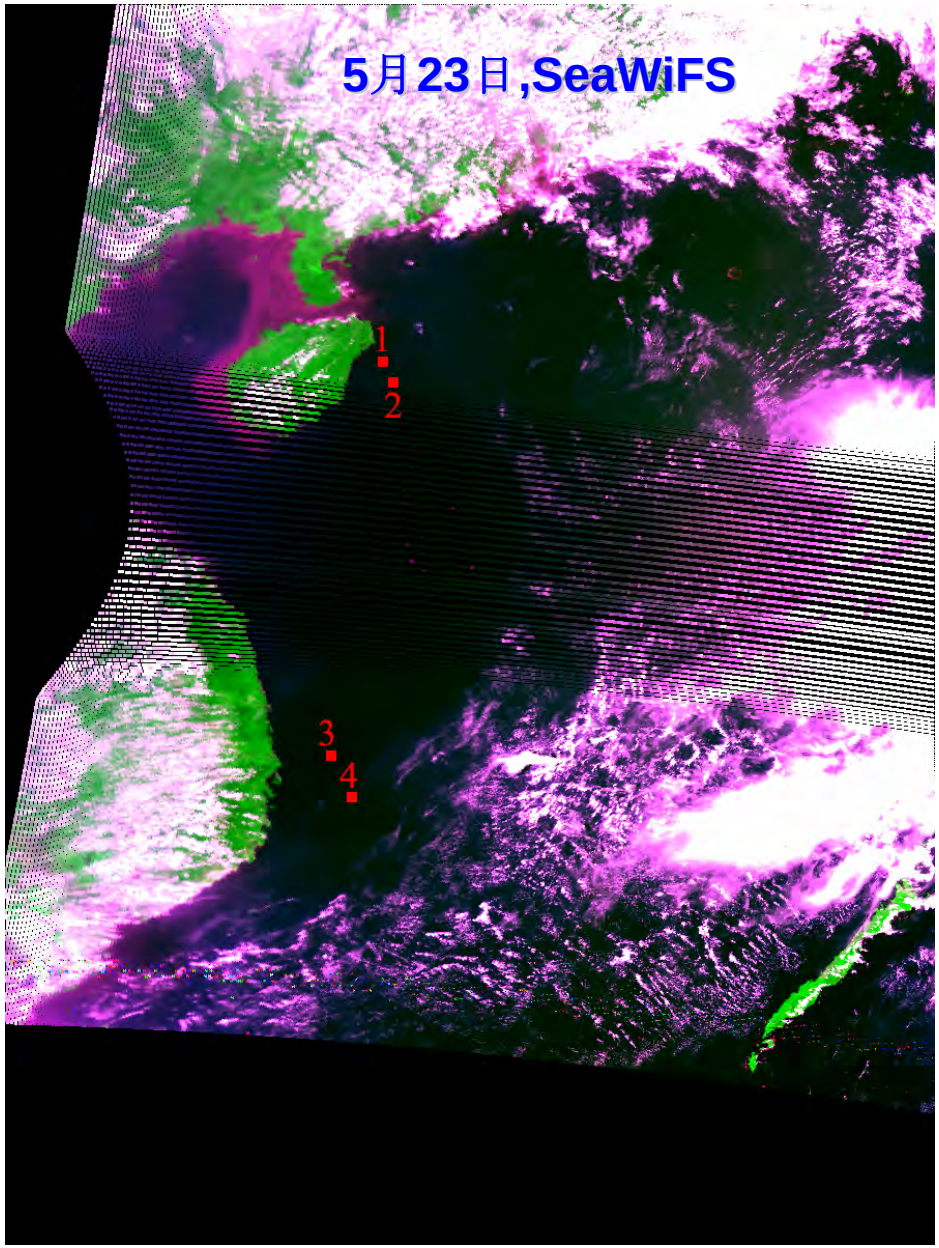

5月13日,COCTS
1
2

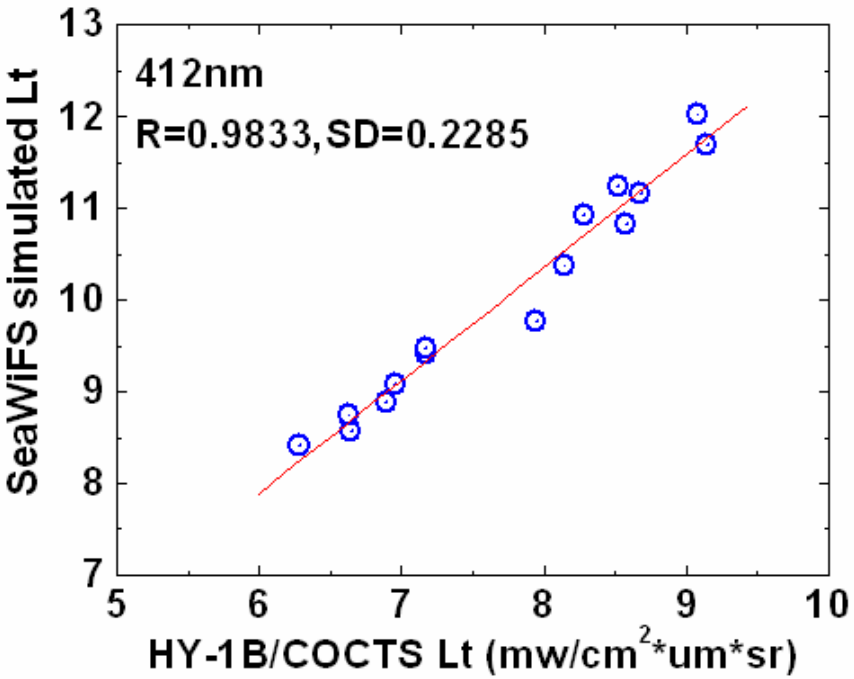

5月13日,SeaWiFS
1
2

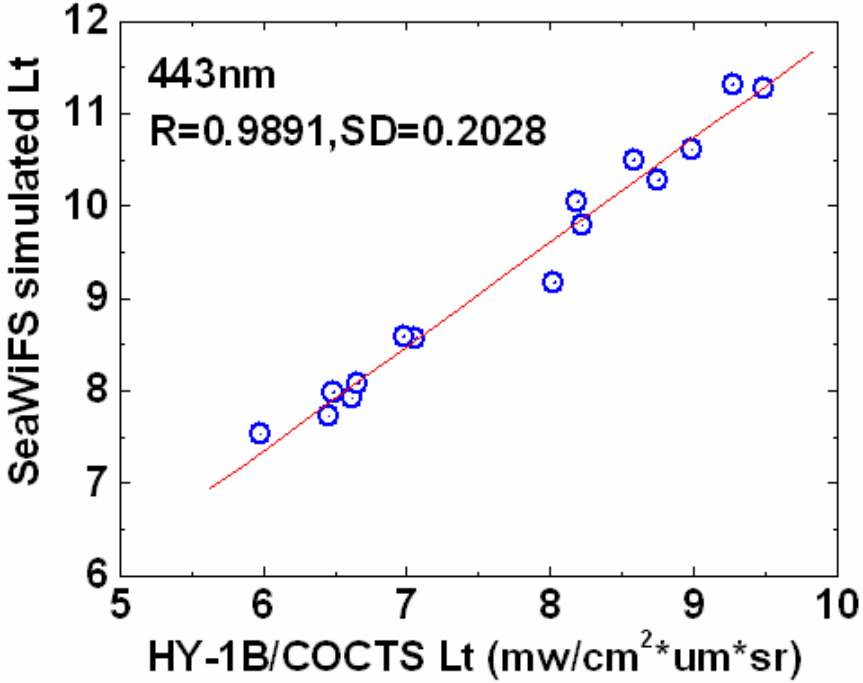

5月16日,COCTS
1
2
4
3

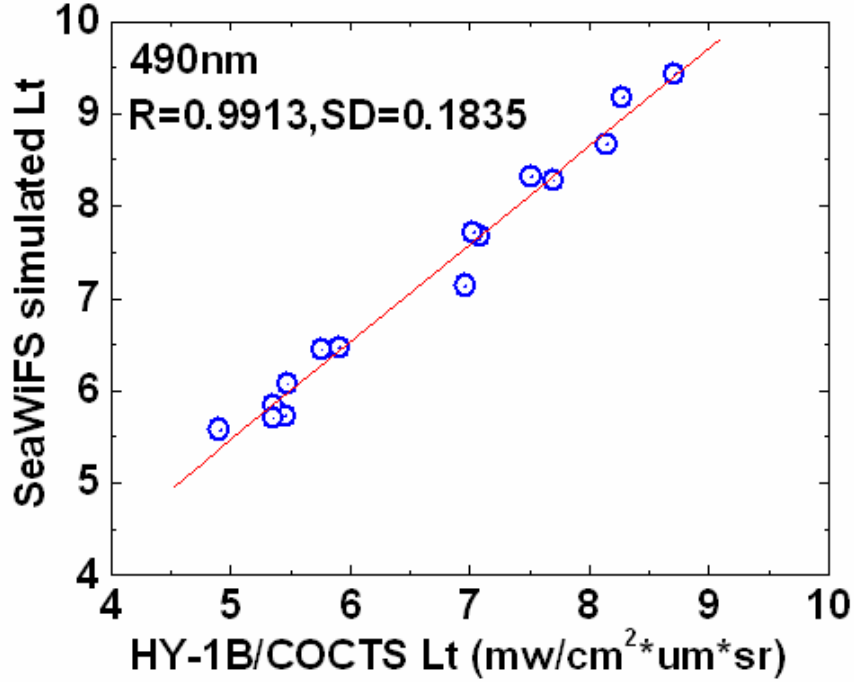

5月16日,SeaWiFS
1
2
4
3

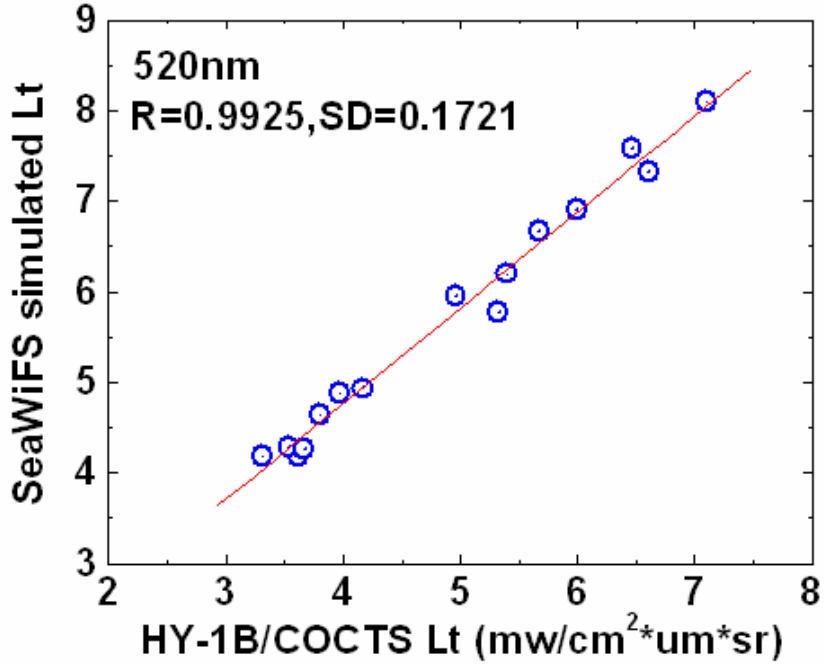

5月23日,COCTS
1
2
3
4

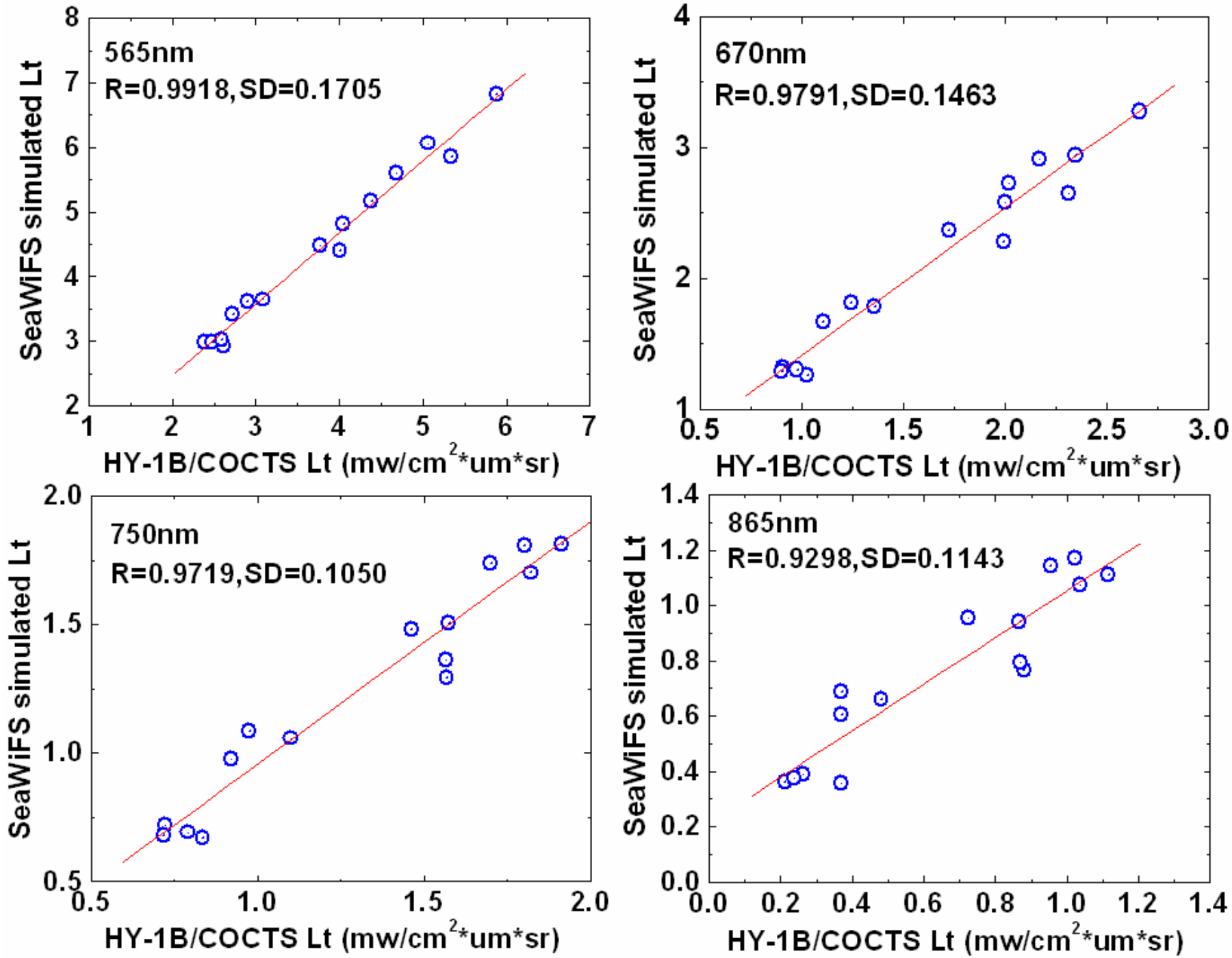

5月23日,SeaWiFS
1
2
3
4


412nm
R=0.9833,SD=0.2285
SeaWiFS simulated Lt
HY-1B/COCTS Lt (mw/cm2*um*sr)


443nm
R=0.9891,SD=0.2028
SeaWiFS simulated Lt
HY-1B/COCTS Lt (mw/cm2*um*sr)


490nm
R=0.9913,SD=0.1835
SeaWiFS simulated Lt
HY-1B/COCTS Lt (mw/cm2*um*sr)


520nm
R=0.9925,SD=0.1721
SeaWiFS simulated Lt
HY-1B/COCTS Lt (mw/cm2*um*sr)

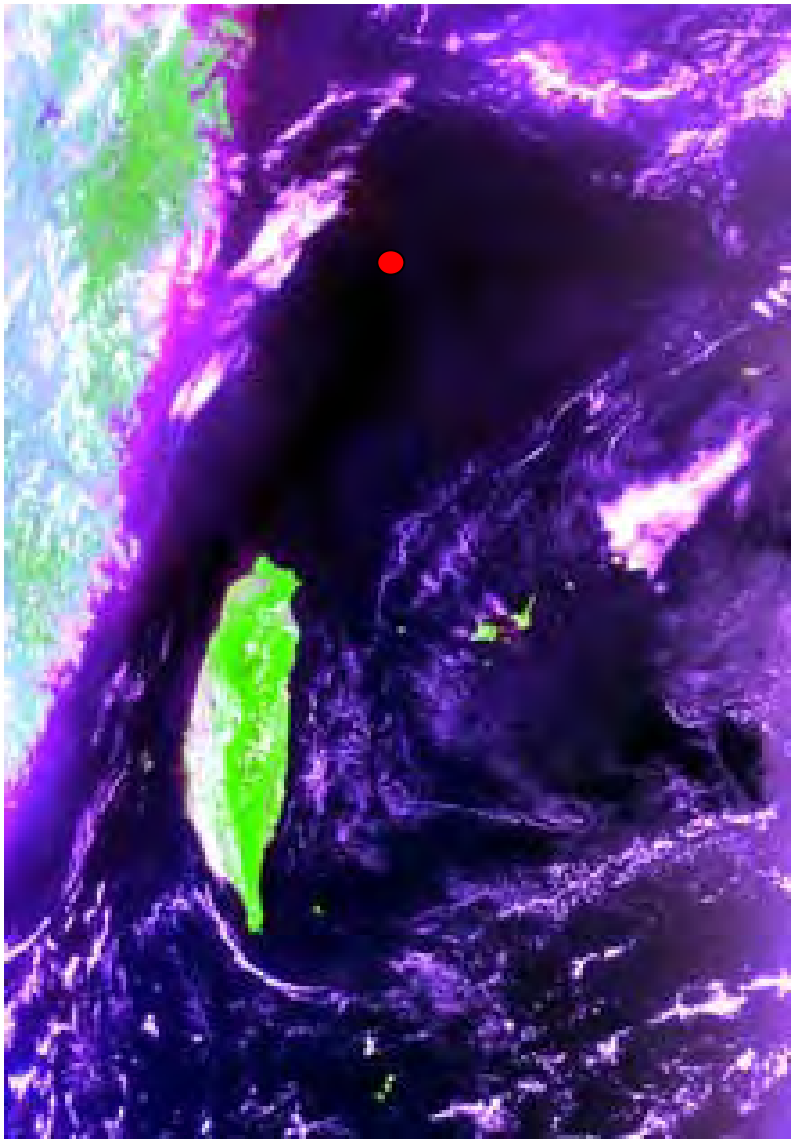

565nm
R=0.9918,SD=0.1705
SeaWiFS simulated Lt
HY-1B/COCTS Lt (mw/cm2*um*sr)
670nm
R=0.9791,SD=0.1463
SeaWiFS simulated Lt
HY-1B/COCTS Lt (mw/cm2*um*sr)
750nm
R=0.9719,SD=0.1050
SeaWiFS simulated Lt
HY-1B/COCTS Lt (mw/cm2*um*sr)
865nm
R=0.9298,SD=0.1143
SeaWiFS simulated Lt
HY-1B/COCTS Lt (mw/cm2*um*sr)

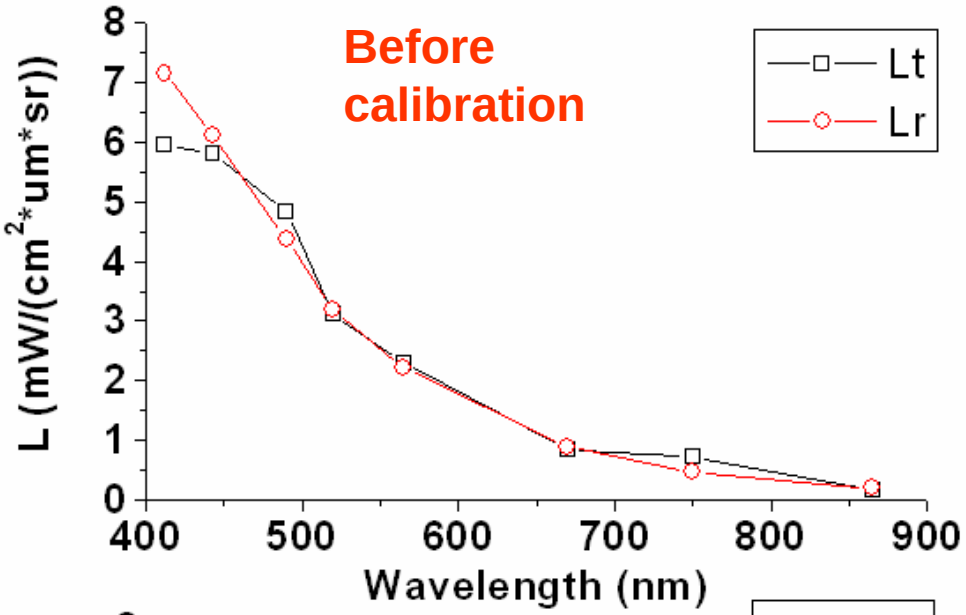
水色波段交叉定　系数

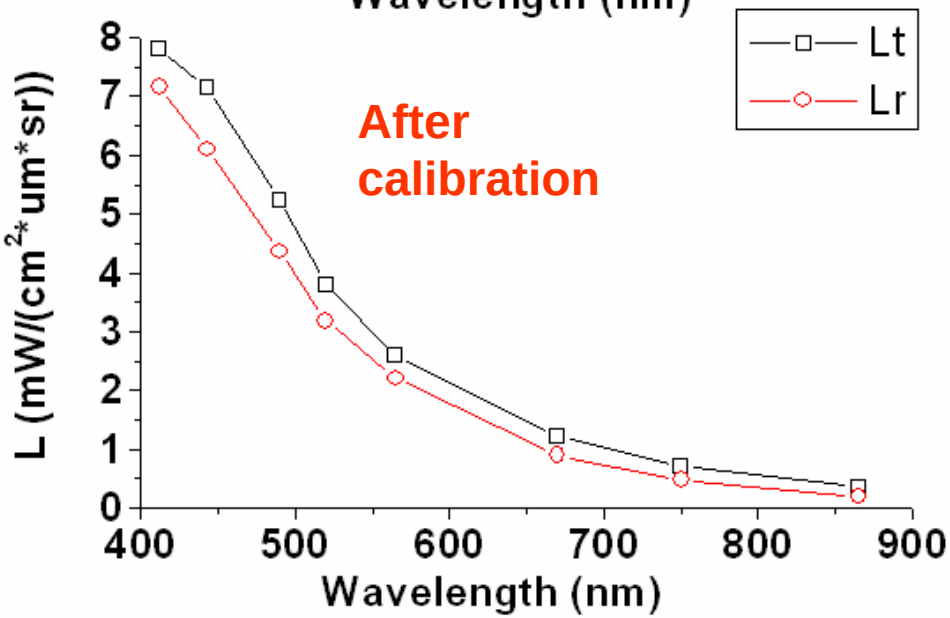
波段	偏置 (offset)	增益 (gain)	相　系数	准方差	方差/均
1			0.9833	0.2285	0.0228
2			0.9891	0.2028	0.0218
3			0.9913	0.1835	0.0254
4			0.9925	0.1721	0.0301
5			0.9918	0.1705	0.0389
6			0.9791	0.1463	0.0682
7			0.9719	0.1050	0.0848
8			0.9298	0.1143	0.1505

$$L_t' = offset + gain \times L_t$$

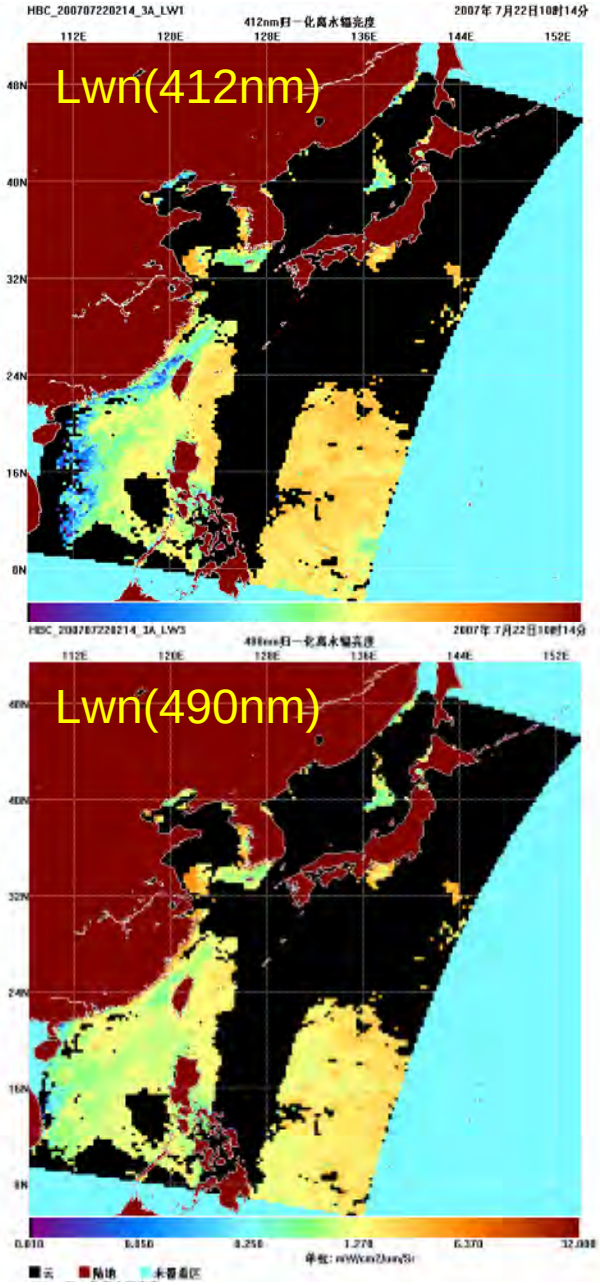
Radiance comparing

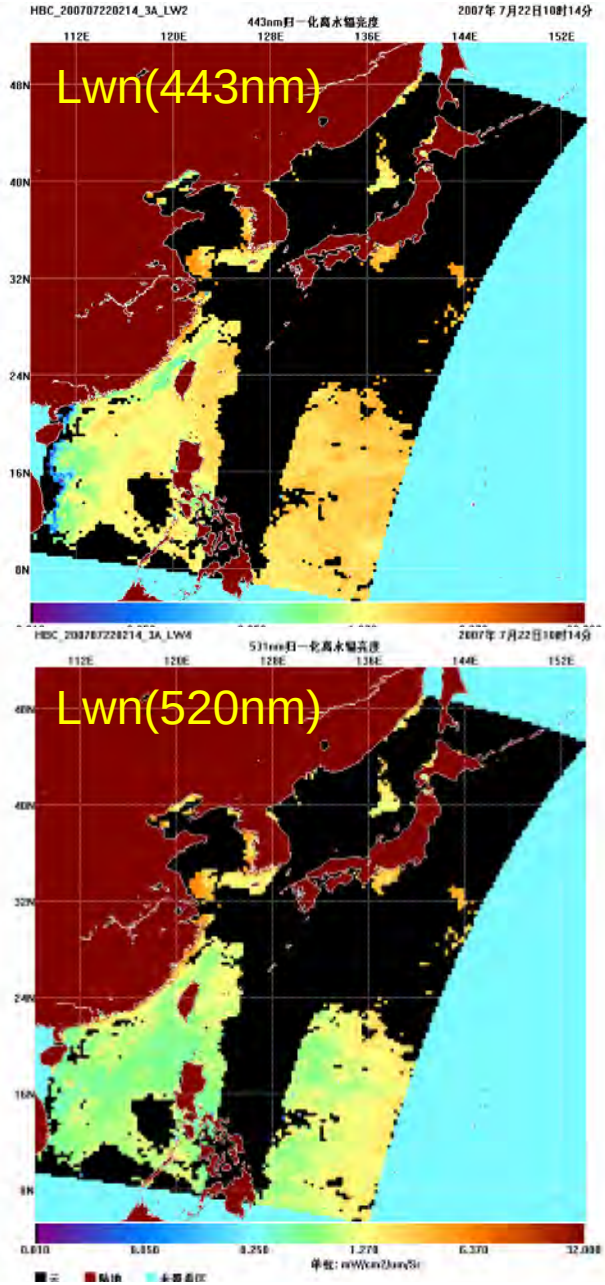




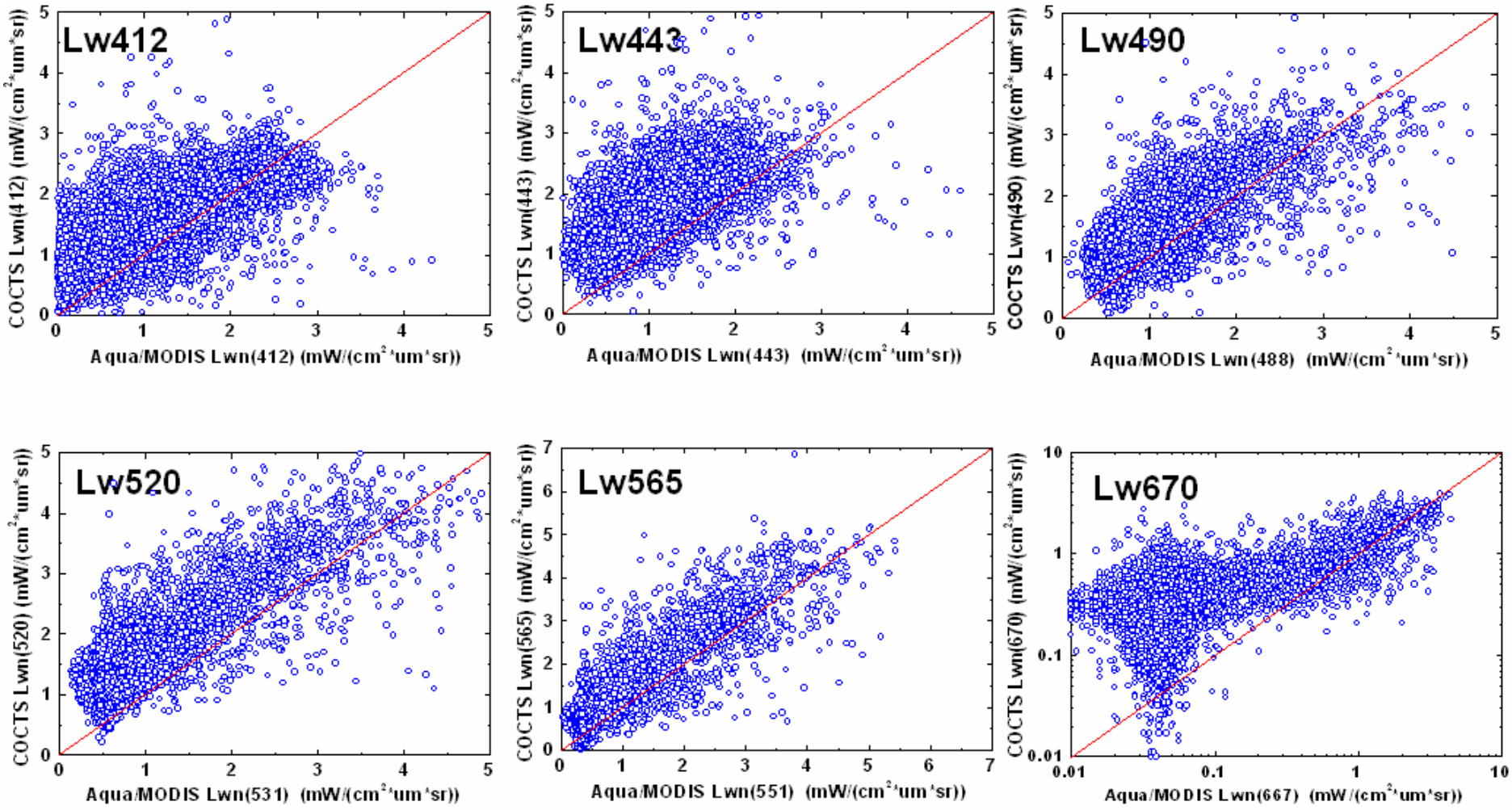


Water leaving radiance from calibration data



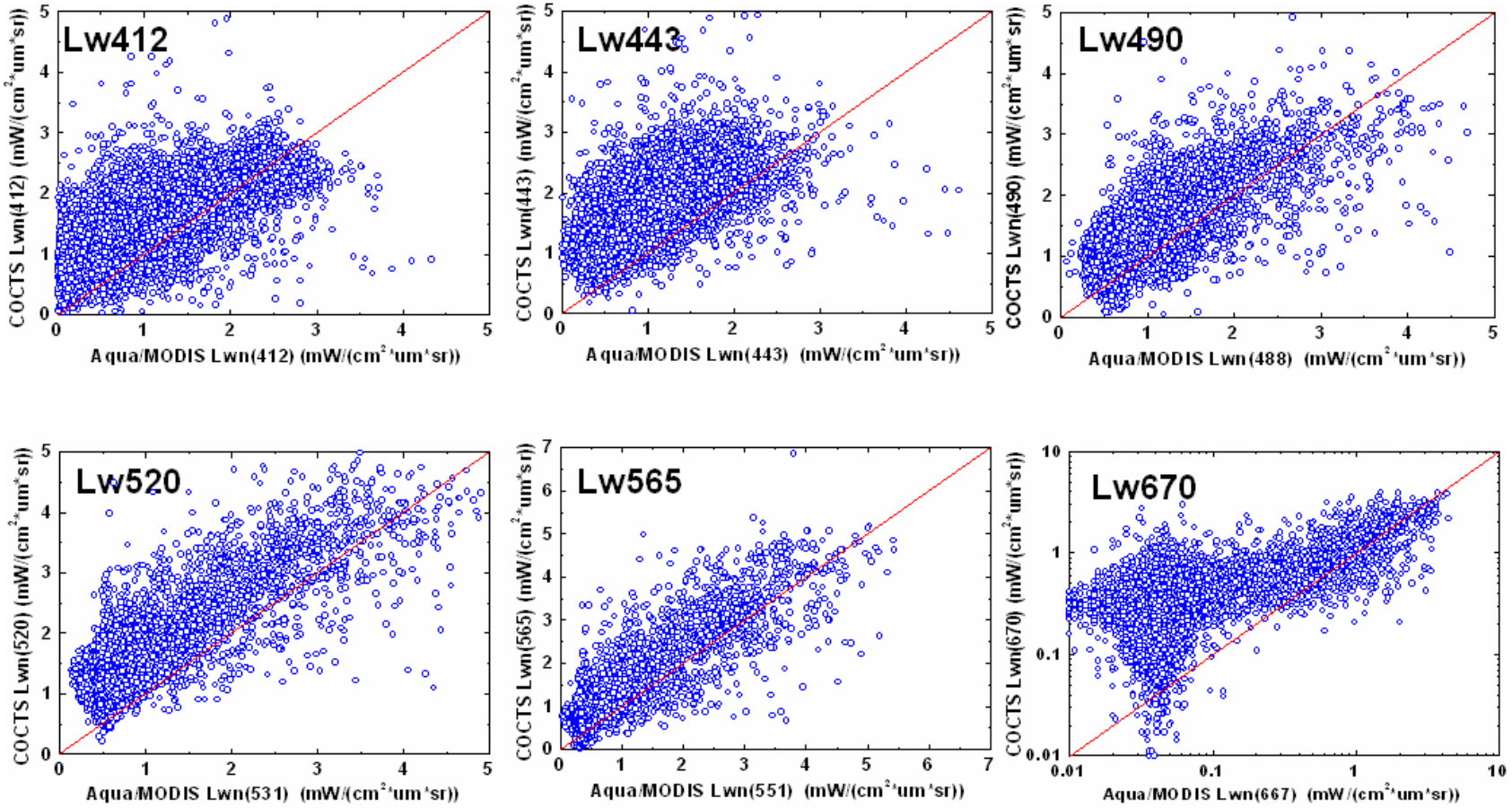


Water leaving radiance comparing with Aqua/MODIS



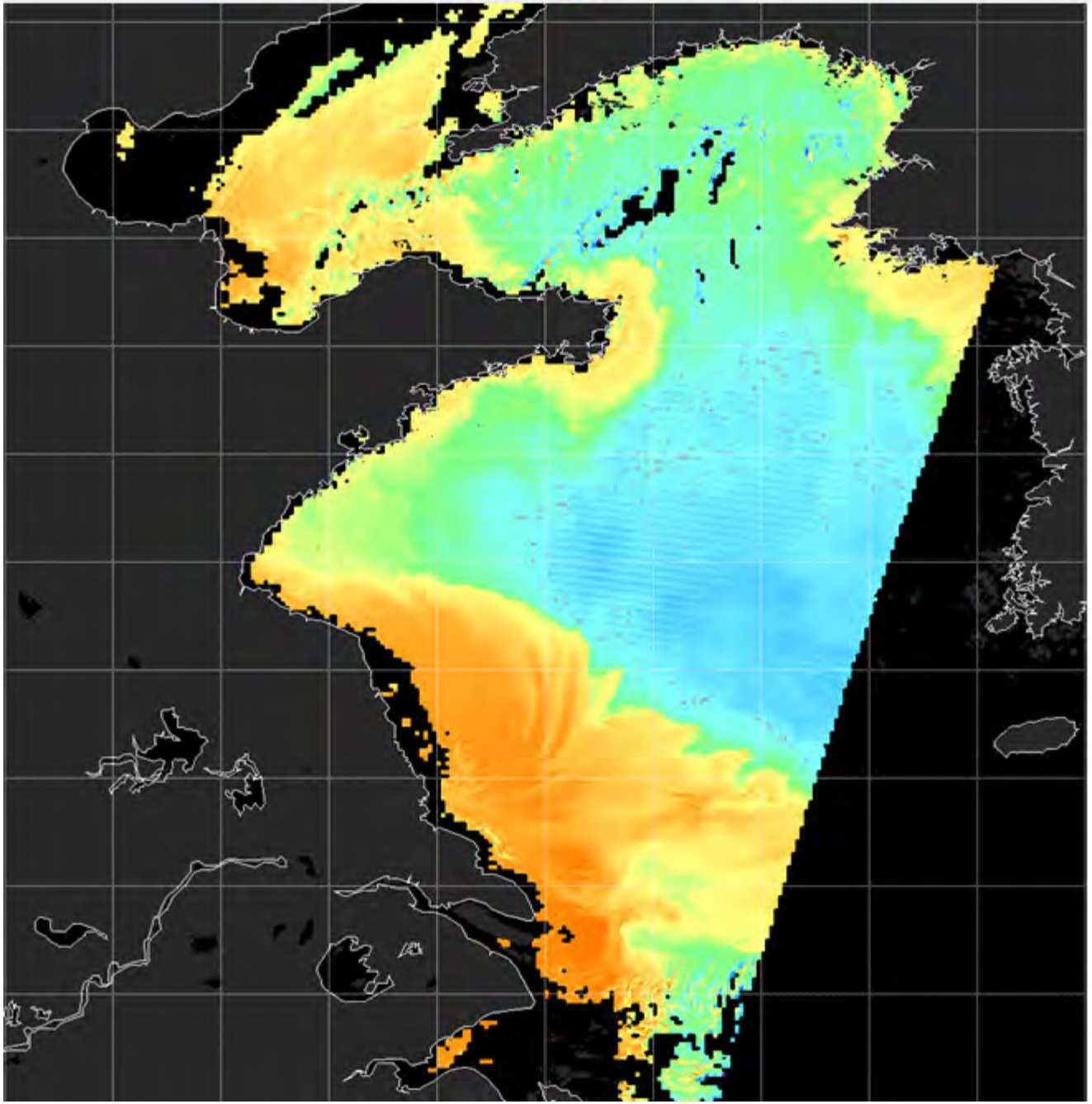
Satellite product comparison between HY-1B and Aqua/MODIS

HY-1B

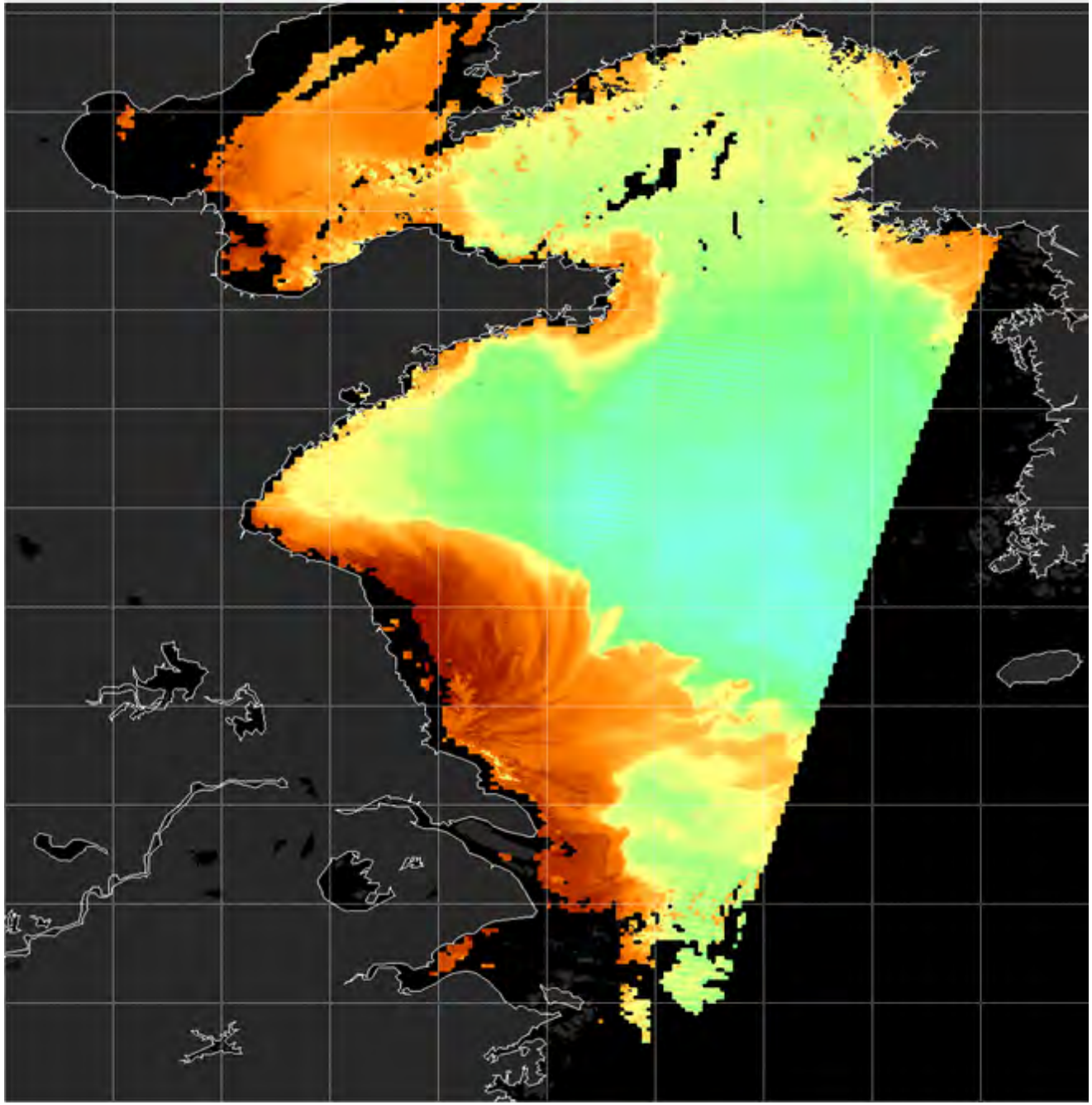


Aqua/MODIS

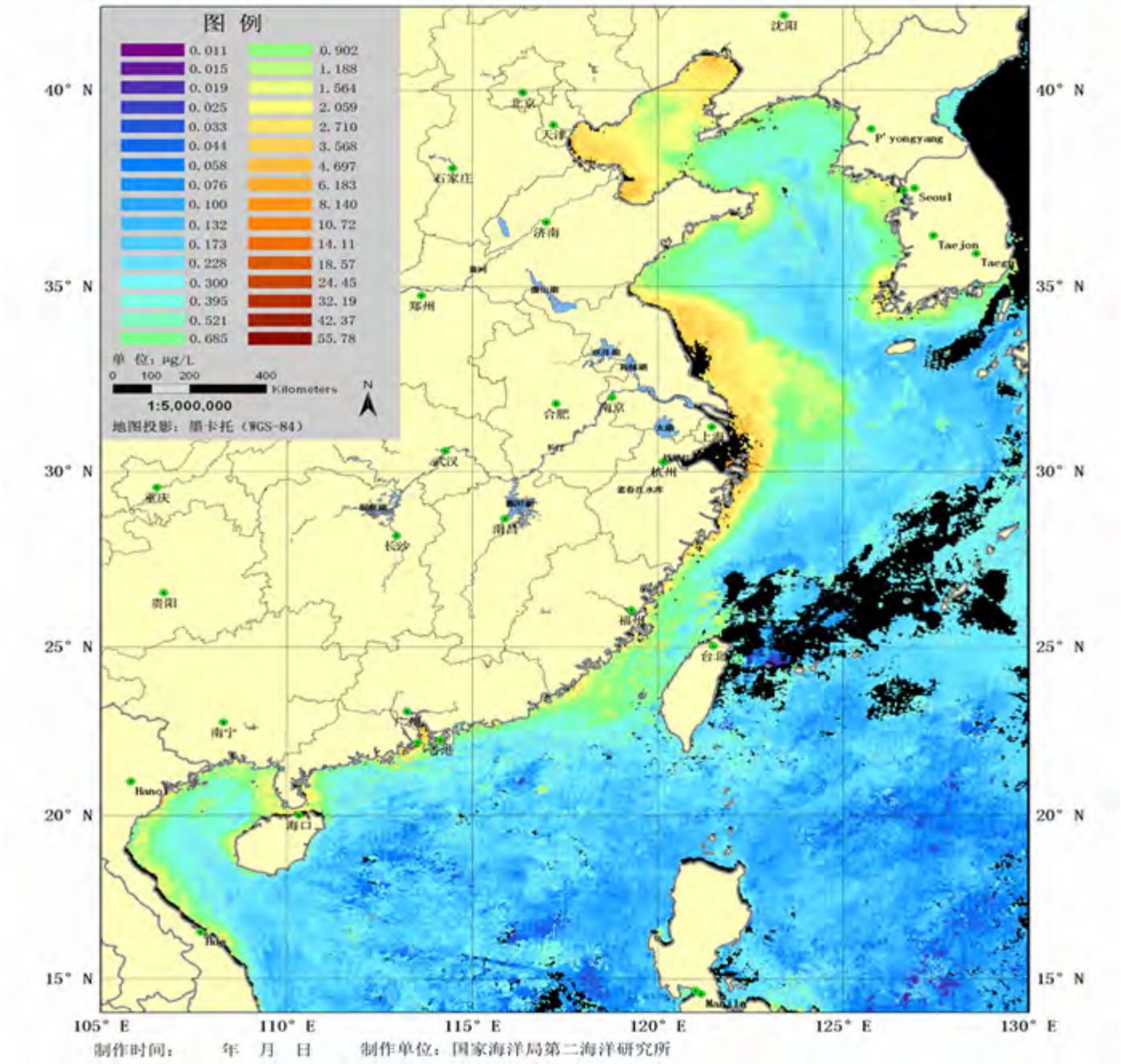
HY-1B 20 May, 2007 Chl a



HY-1B 20 May, 2007 TSM

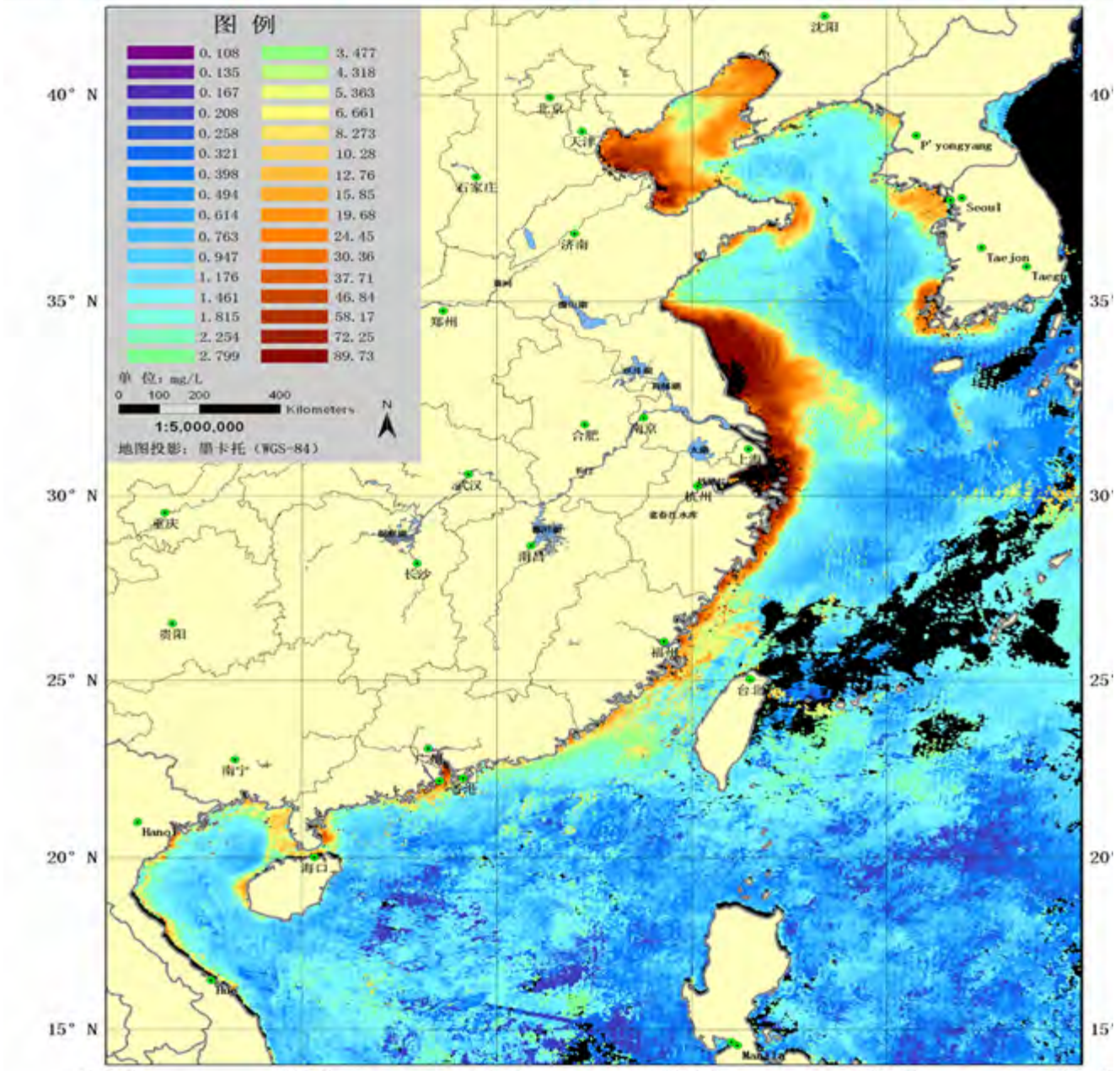


Monthly Chla in May by HY-1B/COCTS



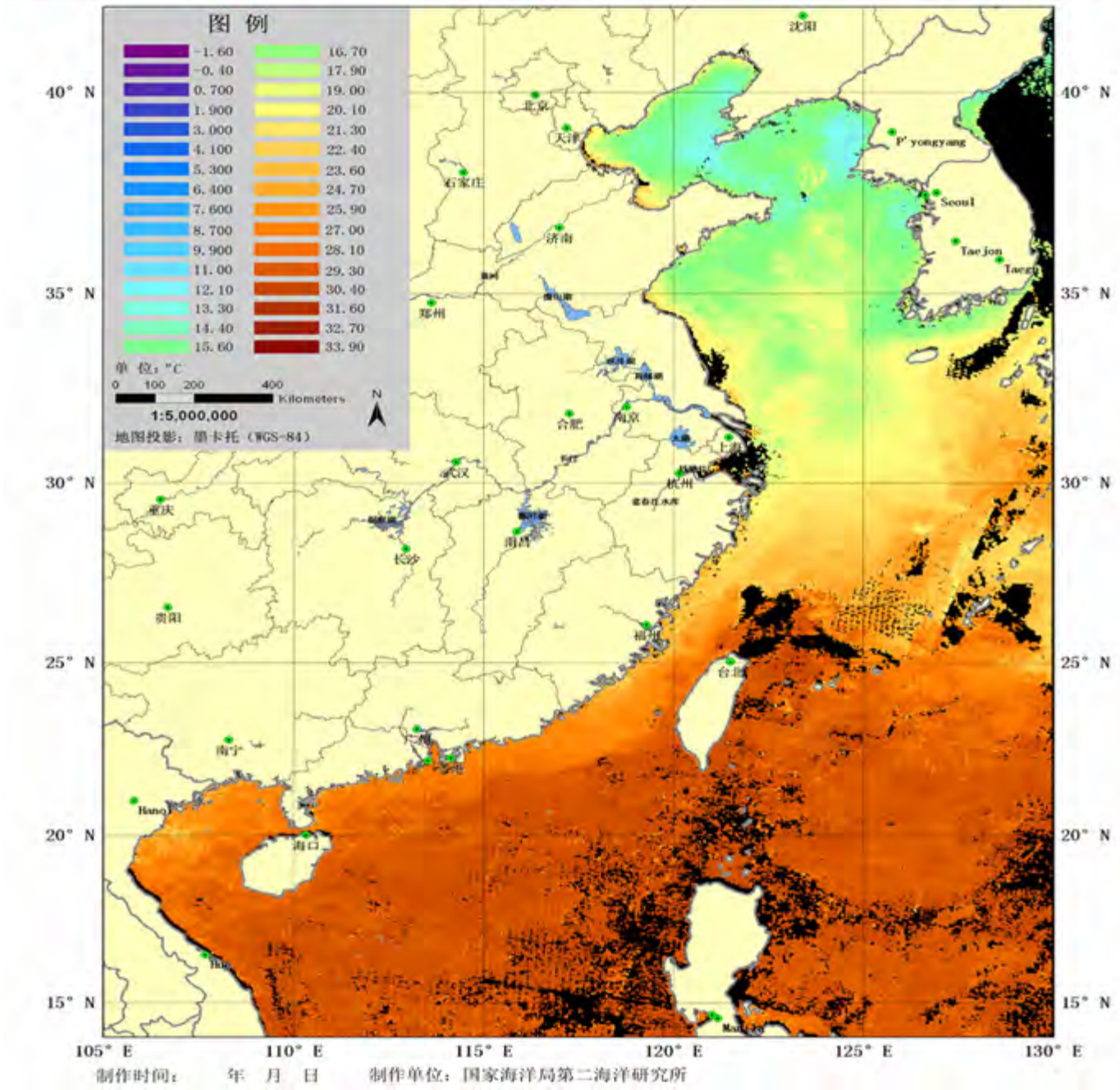
制作时间：　　年　月　日　　制作单位：国家海洋局第二海洋研究所

Monthly TSM in May by HY-1B/COCT

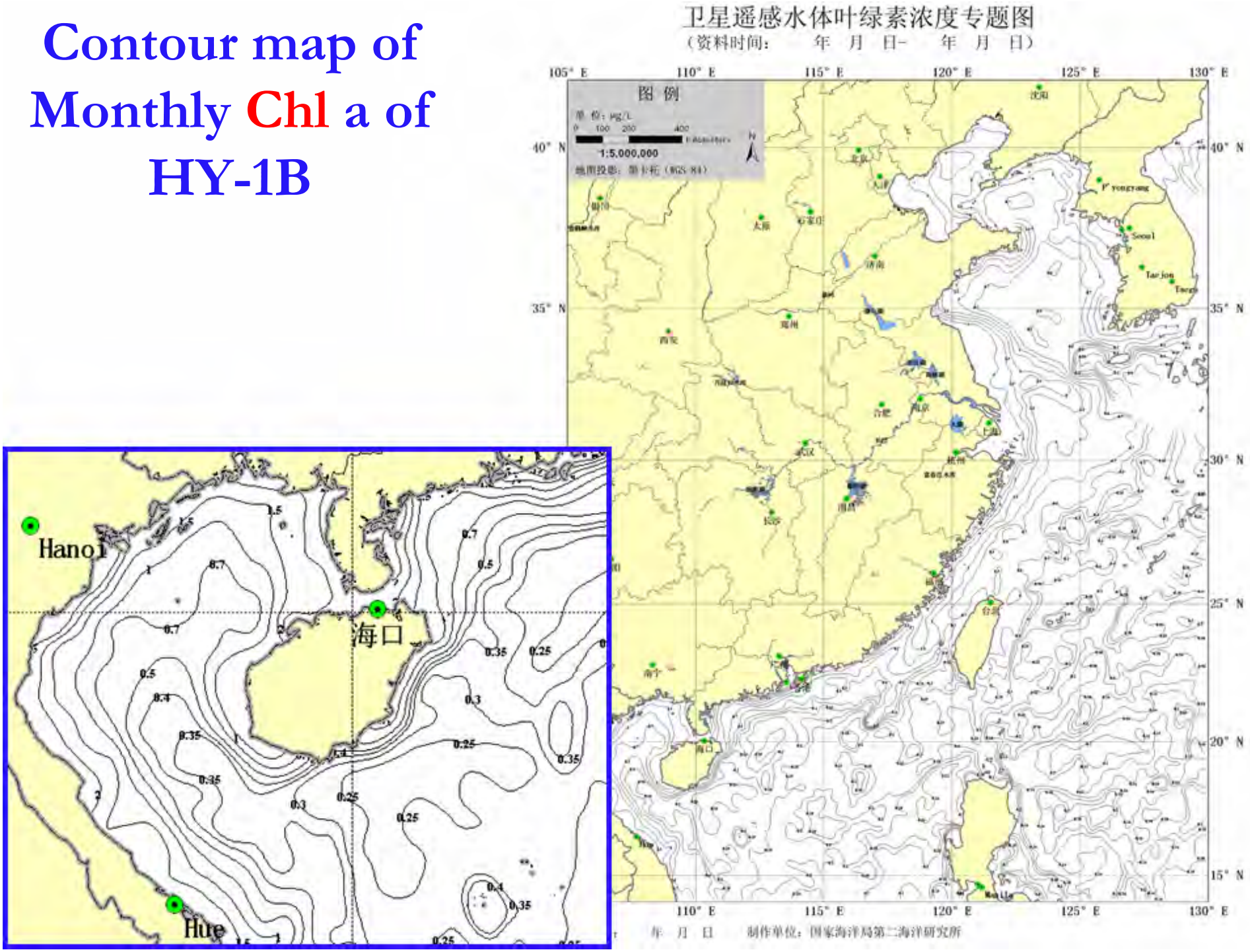


制作时间：　　年　月　日　　制作单位：国家海洋局第二海洋研究所

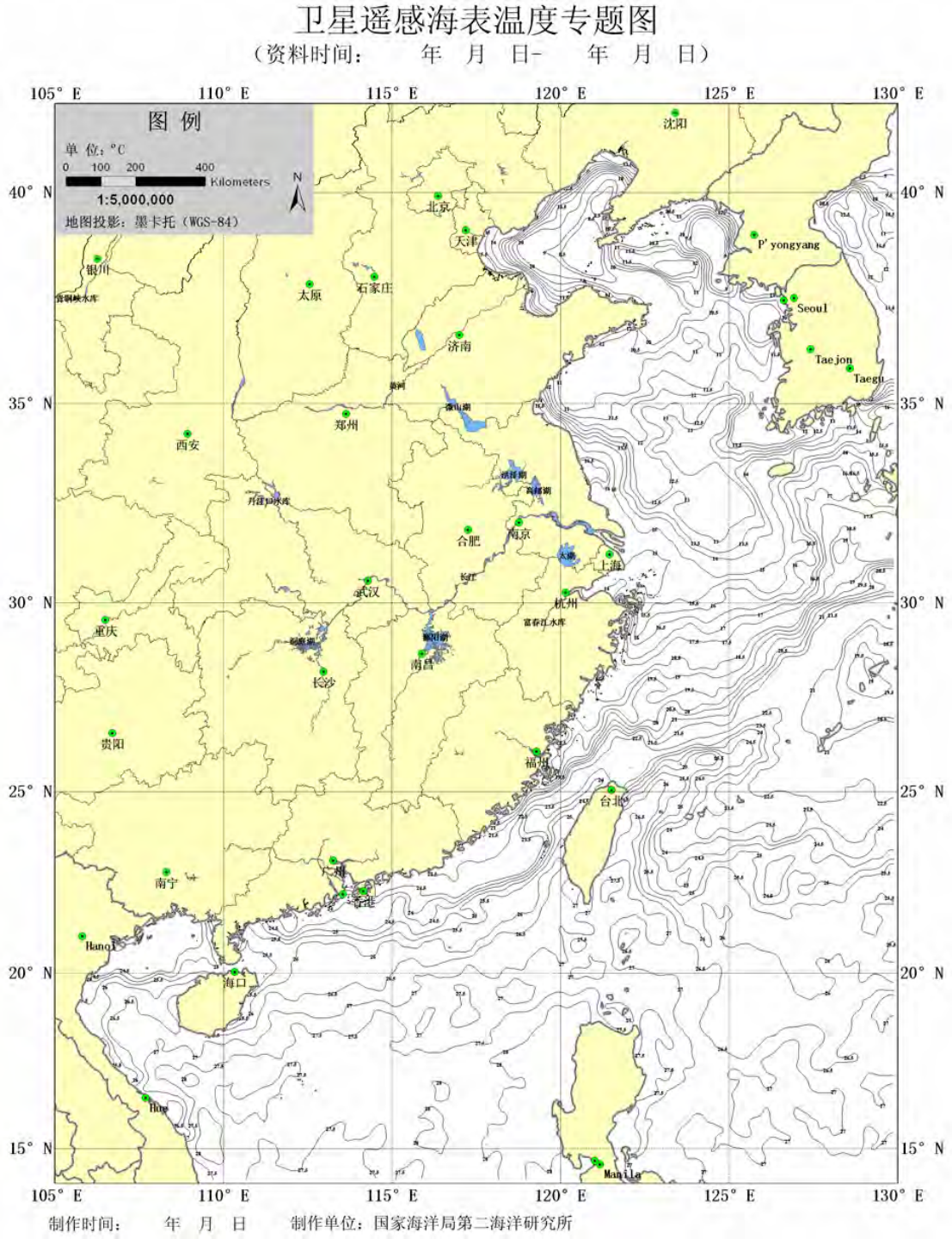
Monthly SST in May by HY-1B/COCTS



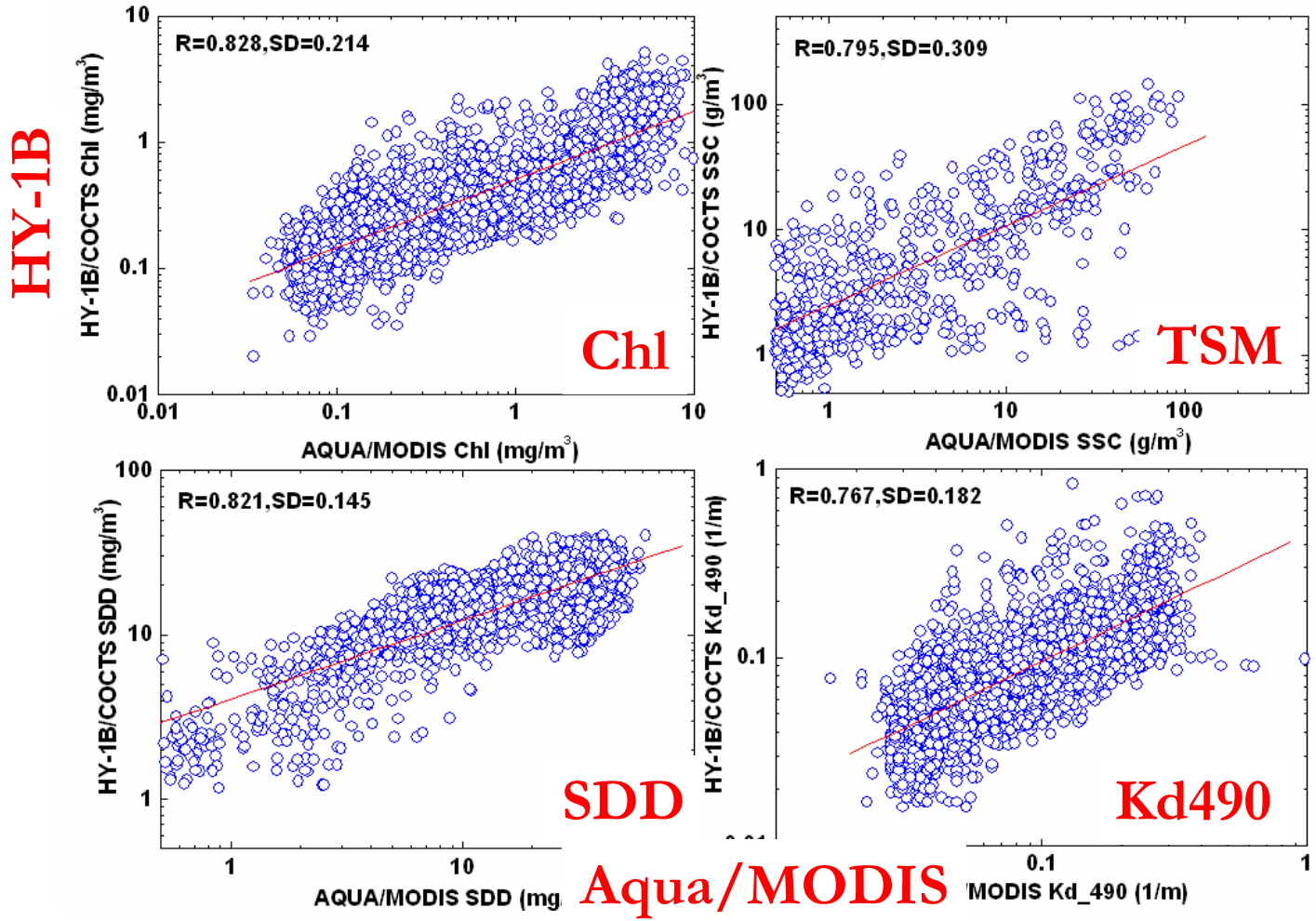
Contour map of Monthly Chl a of HY-1B



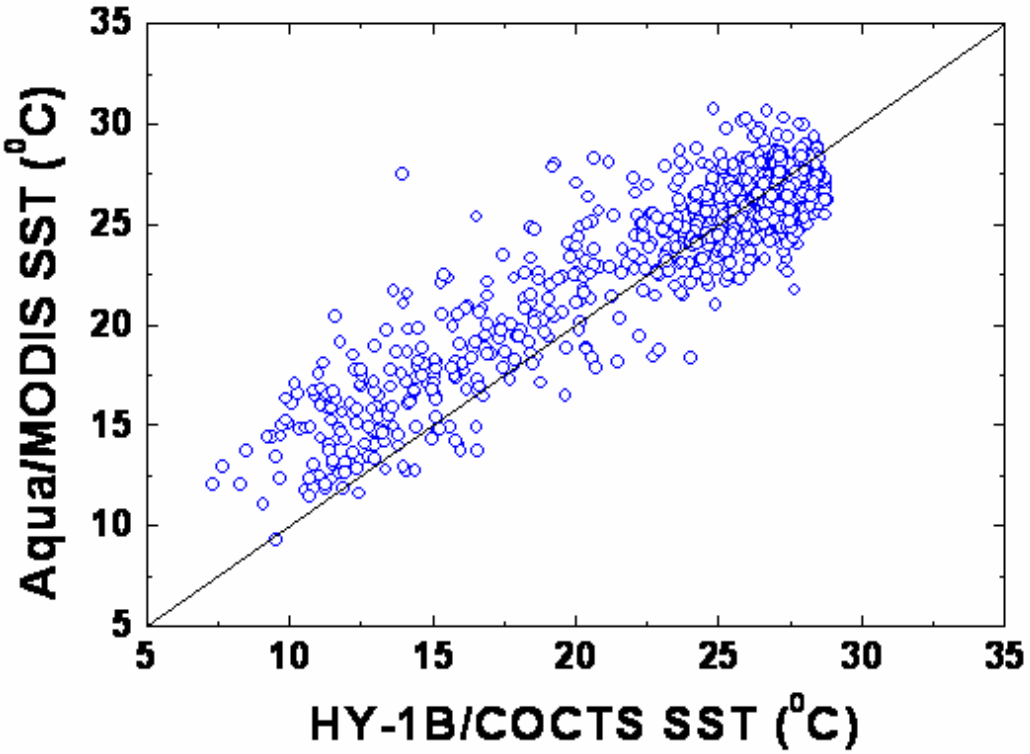
Contour map of Monthly SST a of HY-1B



Satellite-derived comparing with Aqua/MODIS in May



Satellite product comparison between HY-1B and Aqua/MODIS (SST)

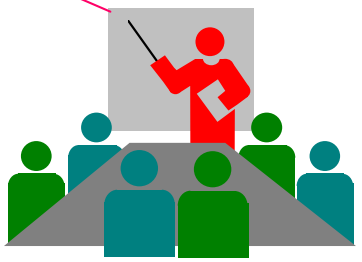


New developments with Haiyang 1B (HY-1B) ocean color satellite

1、Chinese satellite HY-1B in 2007

2、Calibration and validation

3、Application



- HY-1B data merging with other ocean color data
  - SeaWiFS, MODIS, MERIS

ESA-MOST Dragon Programme

Marine Remote Sensing Data Application and Mapping Toolbox

Pan Delu, Bai Yan. SOED/SIO/SOA. Hangzhou, 2007

Ocean color training involved in ESA-MOST Dragon Programme in Oct,15-20, Hangzhou, China

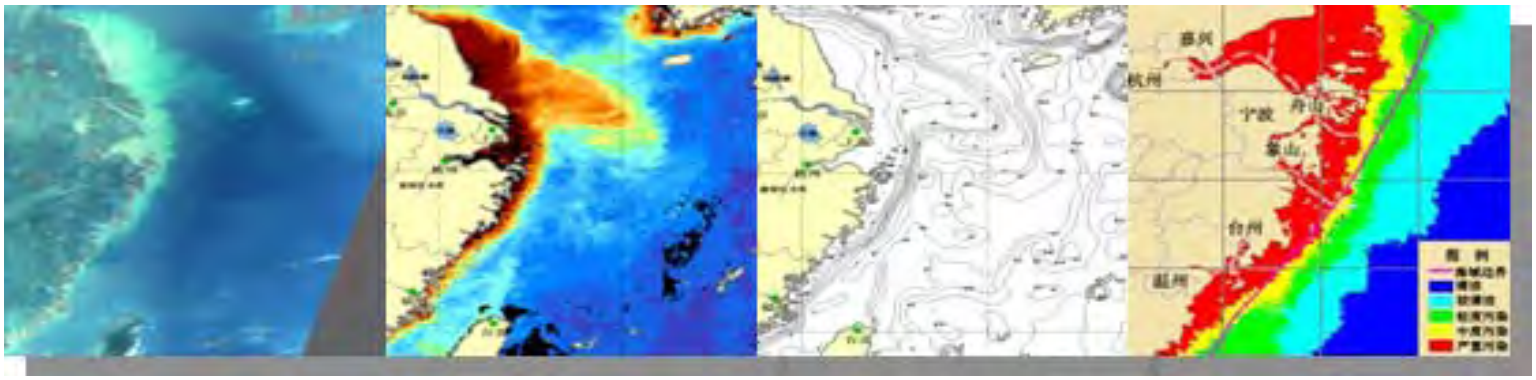
ESA-MOST Dragon Programme

--- Ocean color training exercise

In the training course, we will do A small project

to generate the water quality classification image by ocean color satellite data

(a local example in East China Sea) to go through the major functions of MAPP.



What can you get from MAPP?

With the MAPP software, it is easy to:

a) **Display the Level 2 satellite data from different space agency, including MERIS from ESA, SeaWiFS and MODIS from NASA, and Chinese ocean color satellite series, like COCTS/HY-1B.**

b) **Subset your Region of Interesting (ROI), with several way of area definition;**

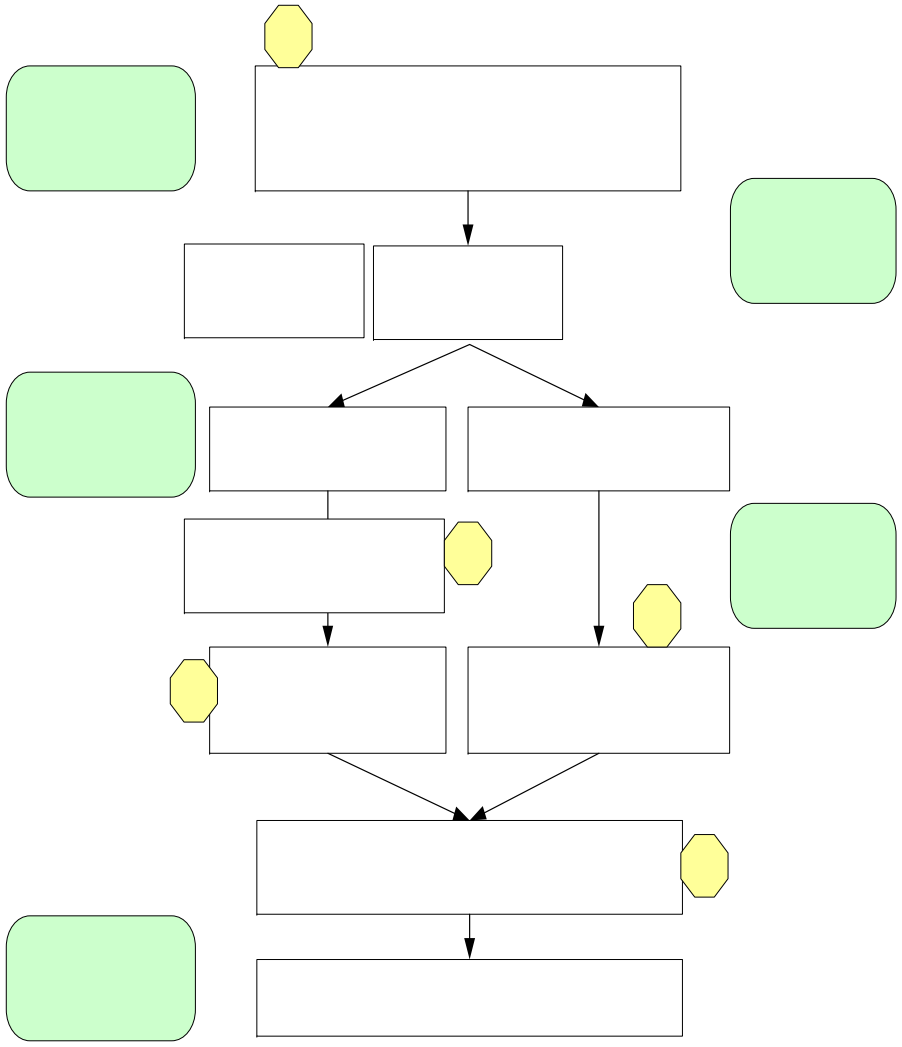
c) **Evaluate the satellite-derived product using the in situ data set.**

d) **Merging the multiple sensors data to improve the data coverage of user desired area and time span.**

e) **Generate the water quality satellite products (total suspended material, water transparency, particle organic carbon, etc.) with some published algorithms, or user-defined local algorithms with the Editor of function expression;**

f) **Map the satellite water quality classification image using several satellite products and methods of water quality assessment.**

General idea



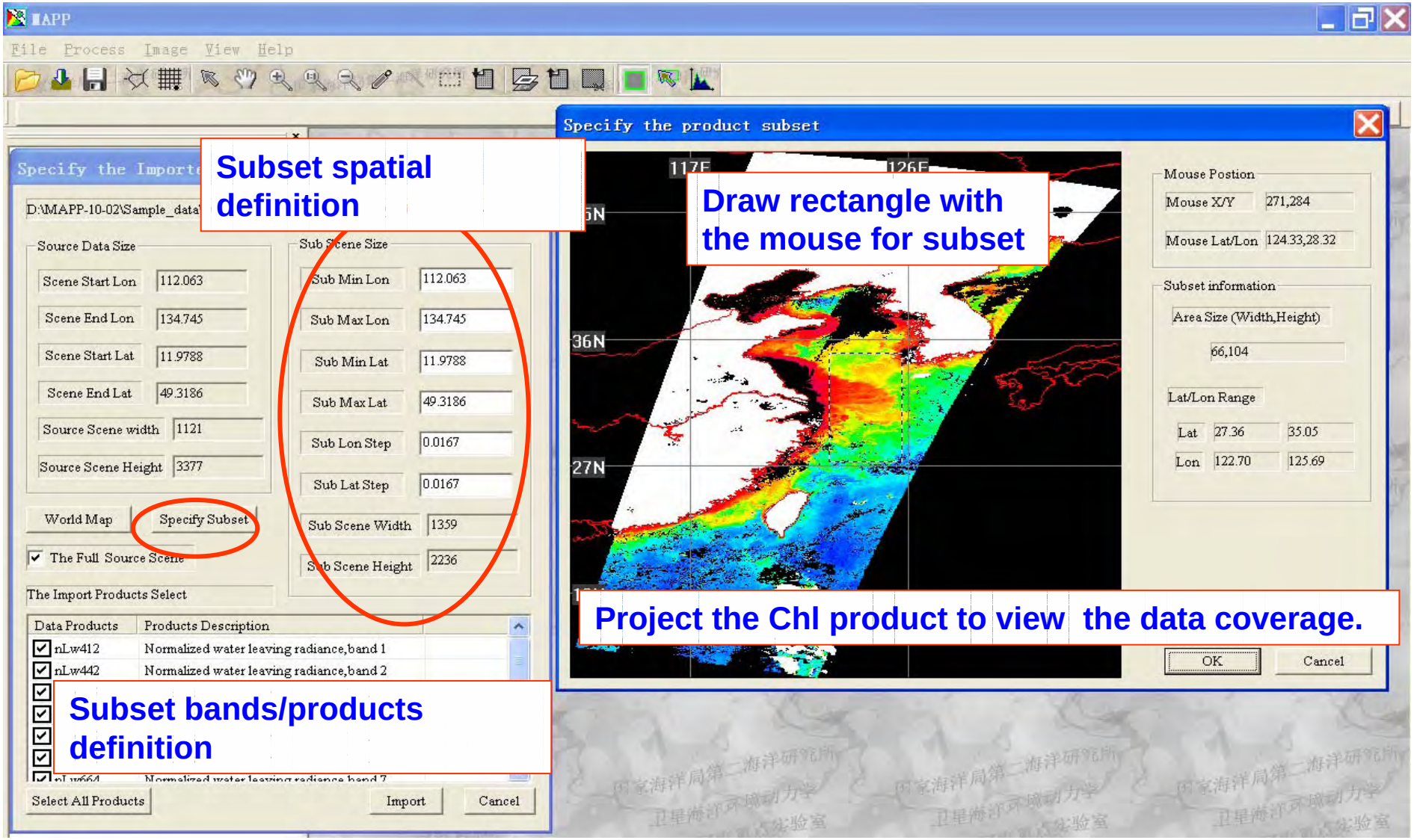
Data Input

- Step 1: Data input and display, importing the L2 data of MERIS, MODIS, SeaWiFS and COCTS/HY-1B, then convert the L2 data into the MAPP.SOA format;
- Step 2: Data collection, selecting the sample points (ROI region) from multiple satellites products;
- Step 3: Data merging, merging the MERIS and MODIS satellite data with the normalization;
- Step 4: Water quality product, retrieving the water quality parameter (such as SDD, TSM, POC, etc) from the Level 3 ocean color products (e.g. Lwn);
- Step 5: Water quality classification, using the satellite-derived water quality products for the water quality classification mapping.

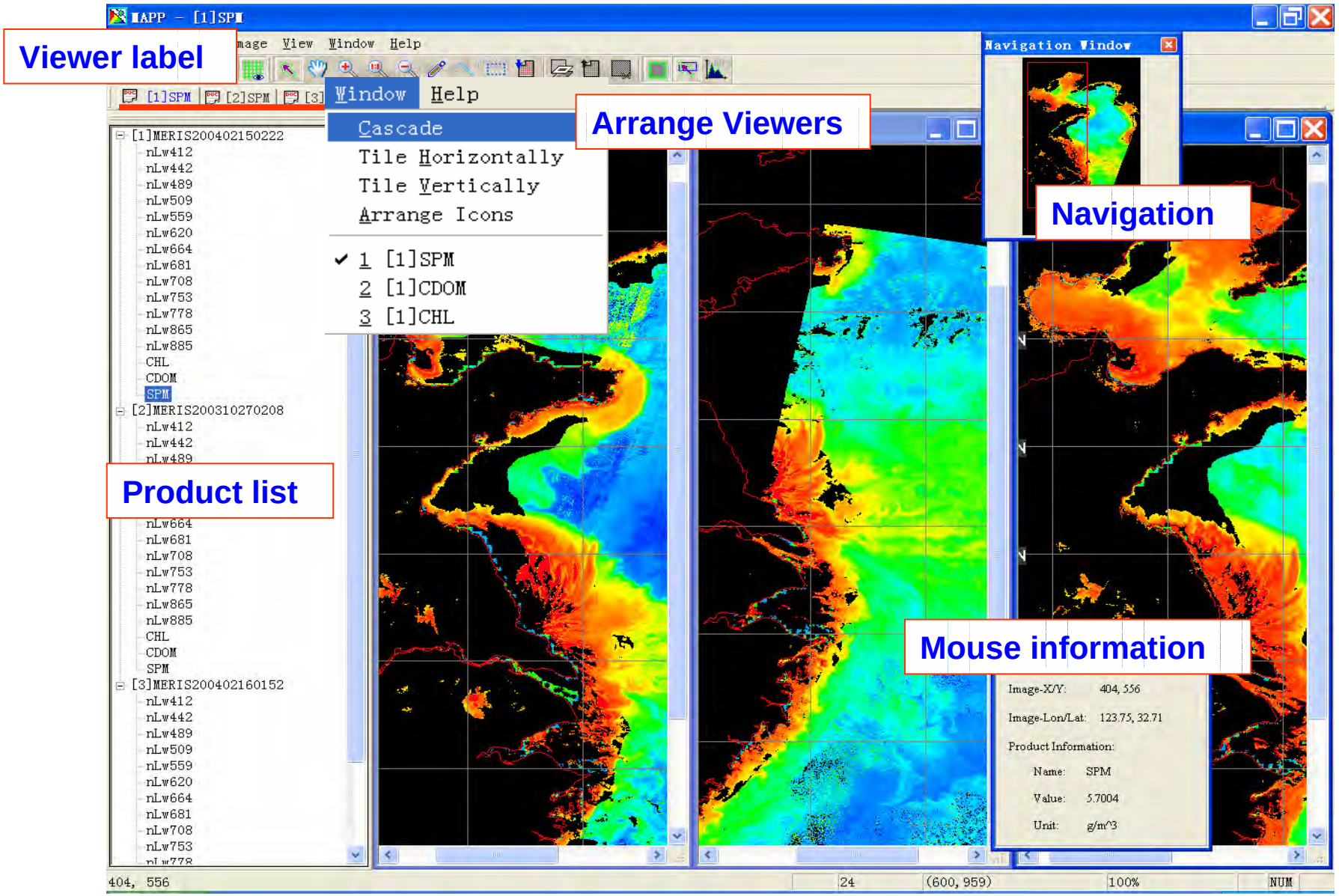
MERIS L2 data, MOD

SeaWiFS L2 data, COC

— Specify the product subset



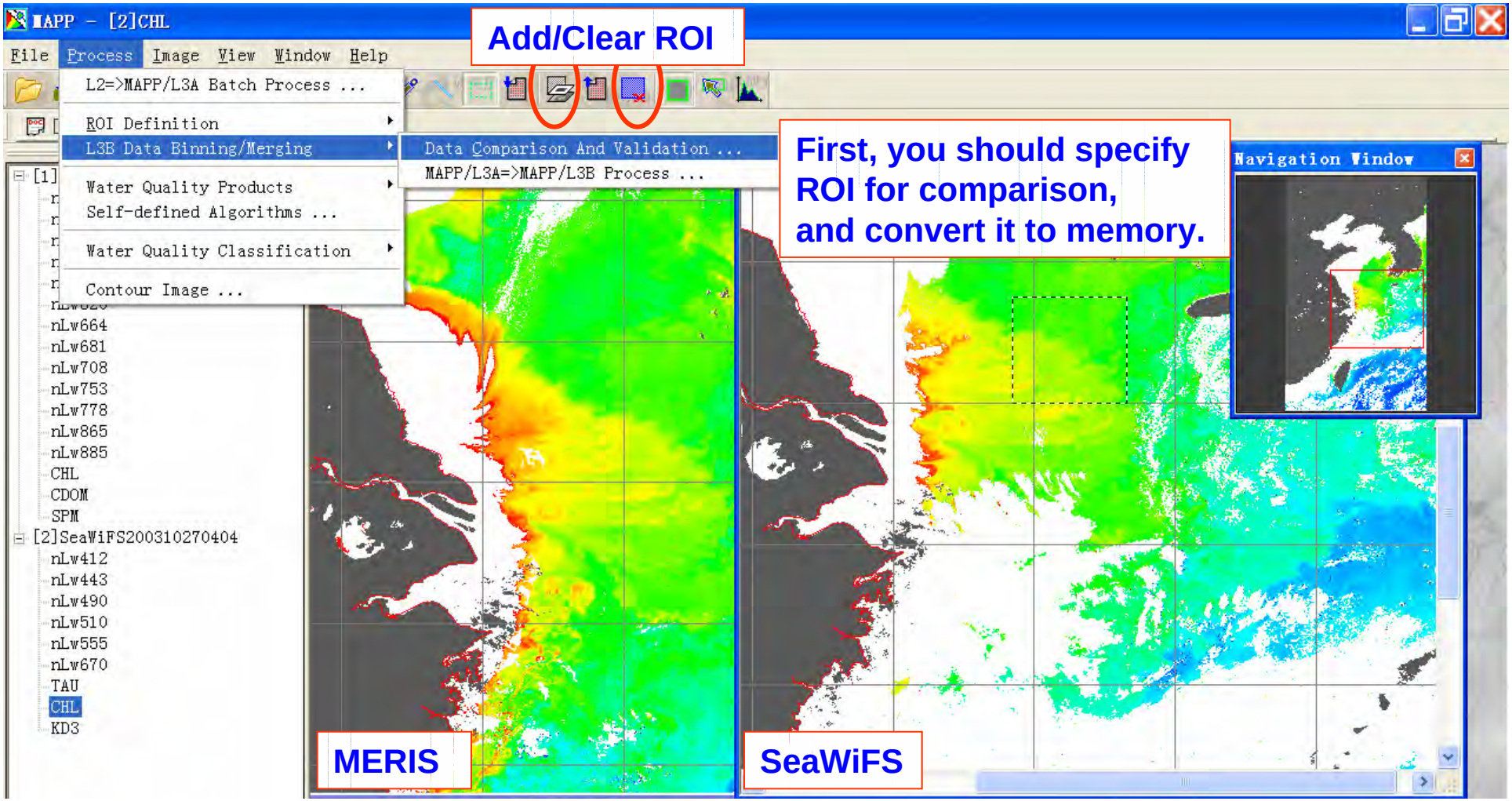
— Image display (1)

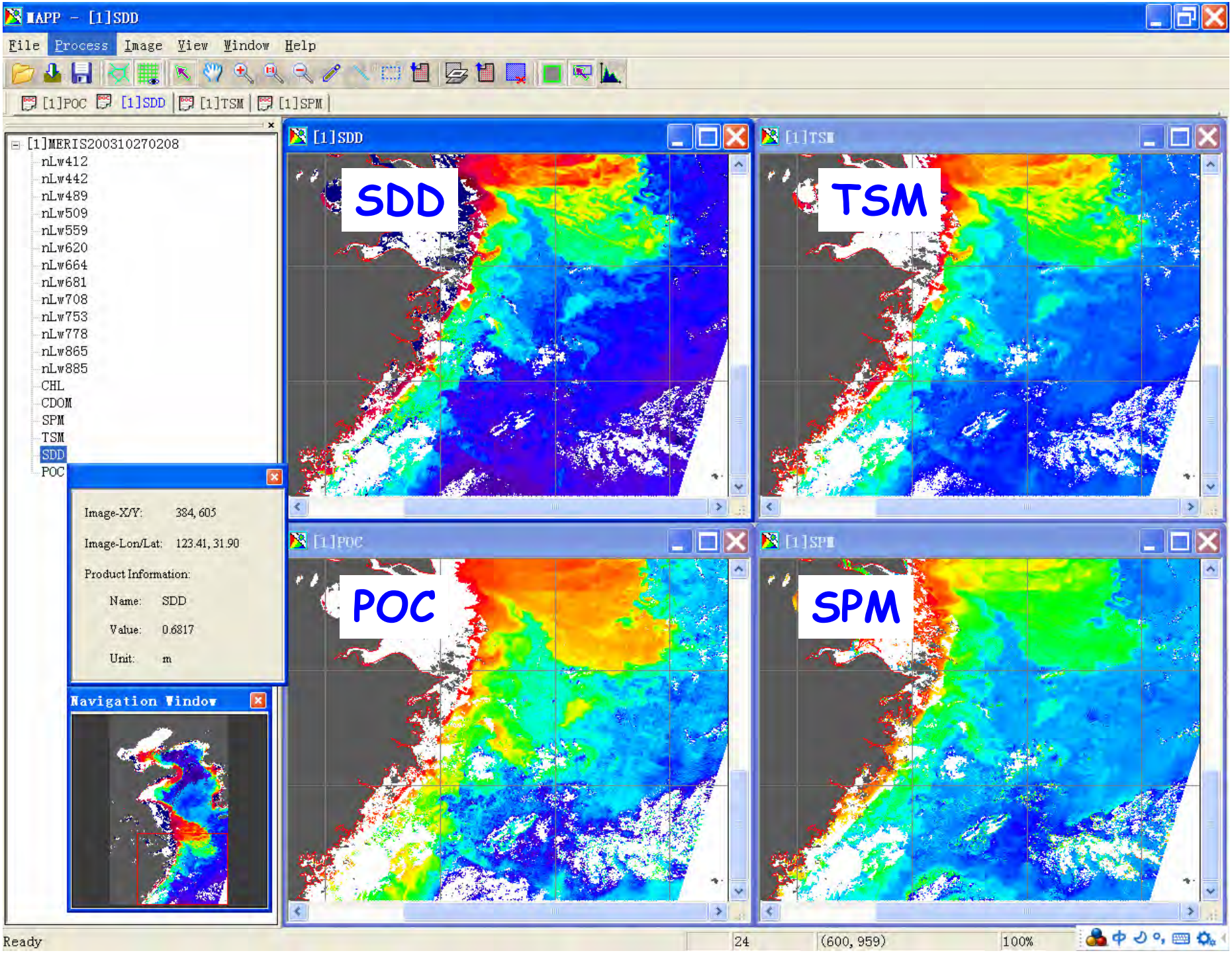


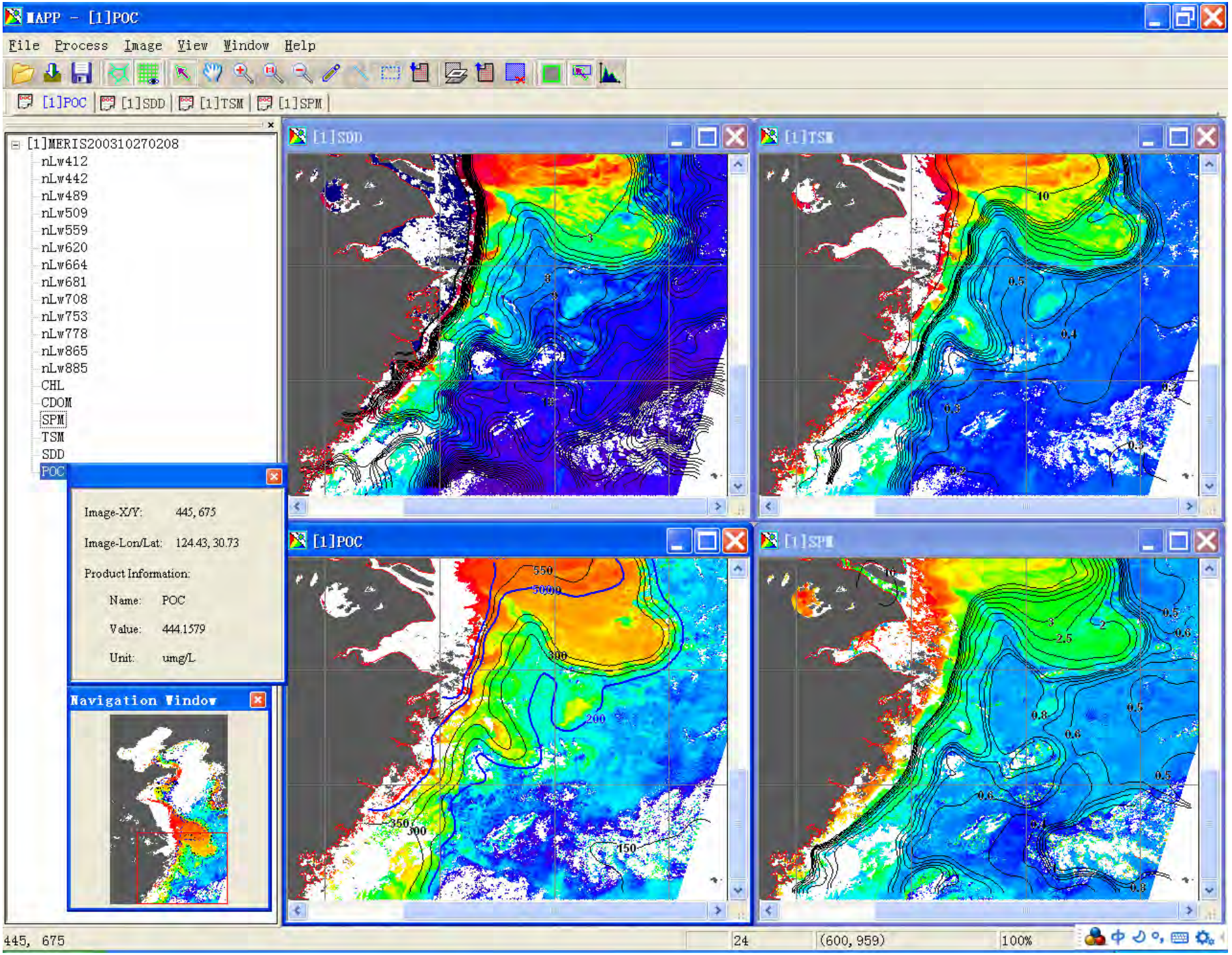
— Data comparison

e.g. MERIS200310270208.soa

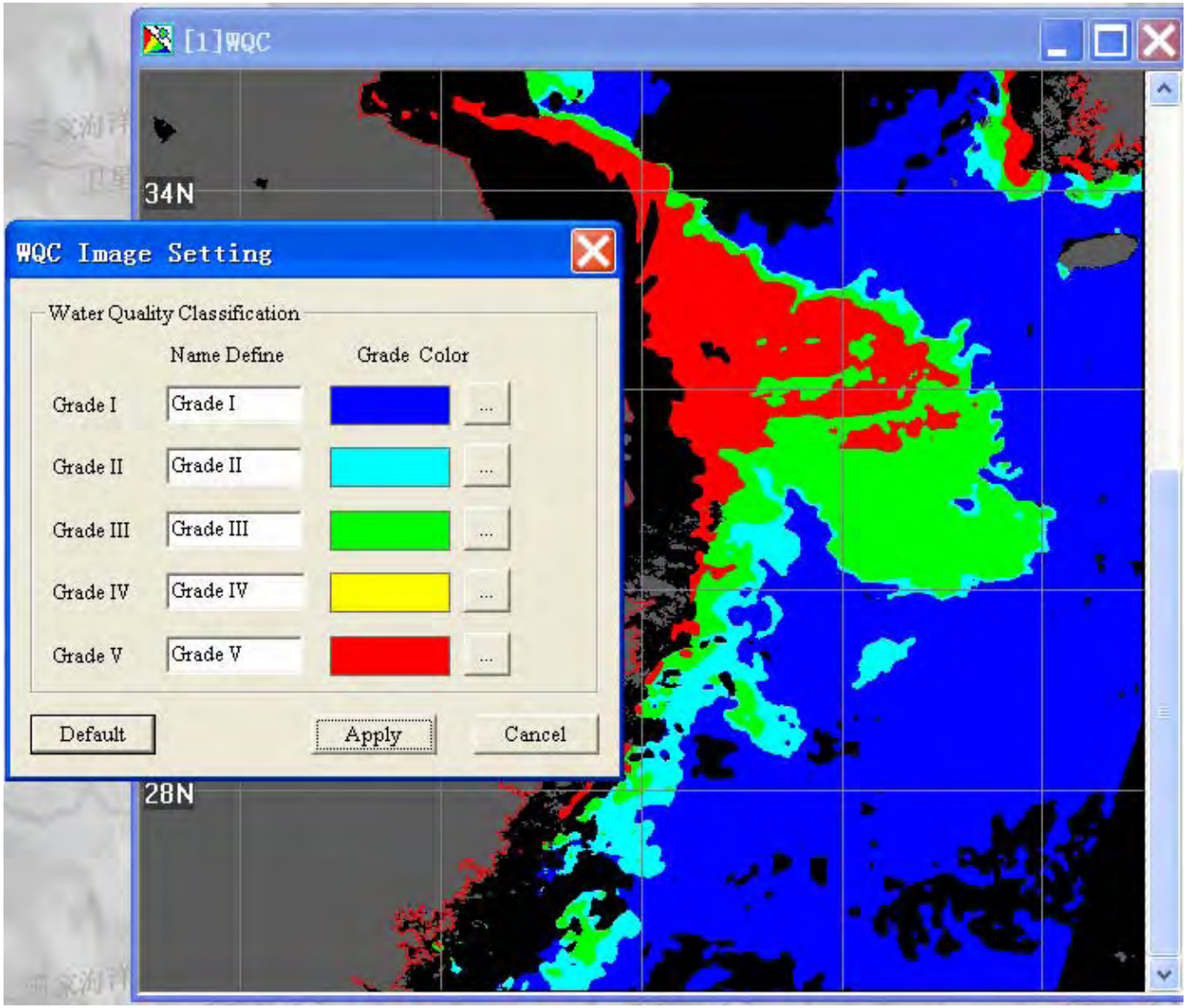
SeaWiFS200310270404.soa



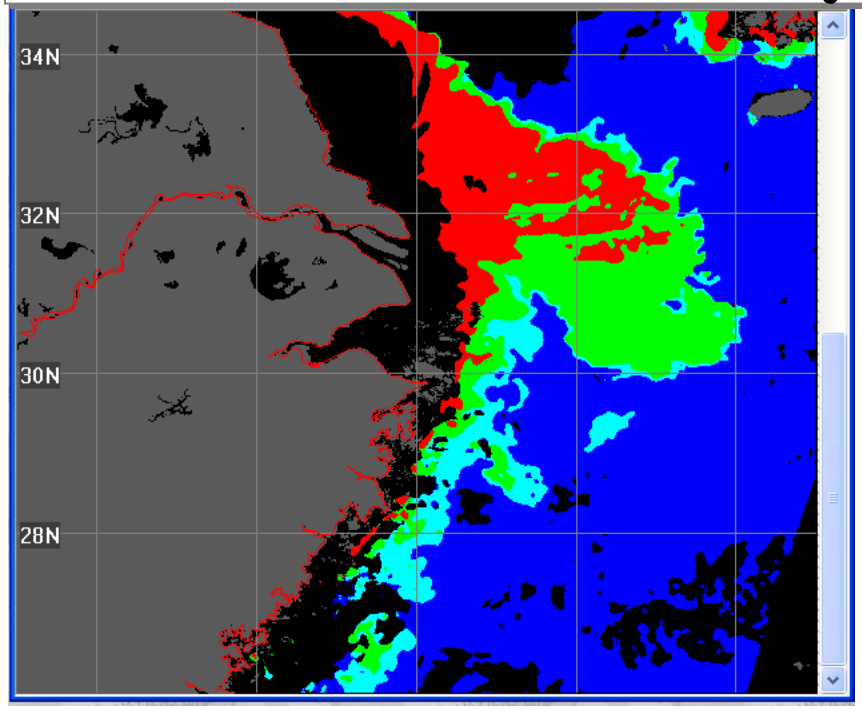

APP - [1]SDD
File Process Image View Window Help
[1]POC [1]SDD [1]TSM [1]SPM
[1]MERIS200310270208
nLw412
nLw442
nLw489
nLw509
nLw559
nLw620
nLw664
nLw681
nLw708
nLw753
nLw778
nLw865
nLw885
CHL
CDOM
SPM
TSM
SDD
POC
Image-X/Y: 384, 605
Image-Lon/Lat: 123.41, 31.90
Product Information:
Name: SDD
Value: 0.6817
Unit: m
Navigation Window
[1]SDD
SDD
[1]TSM
TSM
[1]POC
POC
[1]SPM
SPM
Ready
24
(600, 959)
100%

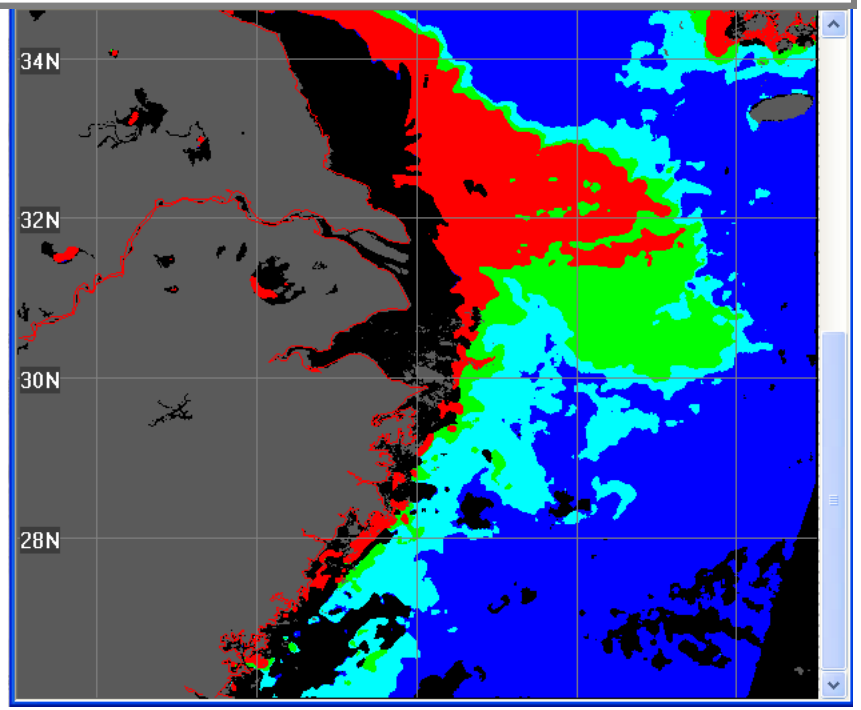

APP - [1]POC
File Process Image View Window Help
[1]POC [1]SDD [1]TSM [1]SPM
[1]MERIS200310270208
nLw412
nLw442
nLw489
nLw509
nLw559
nLw620
nLw664
nLw681
nLw708
nLw753
nLw778
nLw865
nLw885
CHL
CDOM
SPM
TSM
SDD
POC
Image-X/Y: 445, 675
Image-Lon/Lat: 124.43, 30.73
Product Information:
Name: POC
Value: 444.1579
Unit: umg/L
Navigation Window
[1]SDD
[1]TSM
[1]POC
[1]SPM
445, 675
24
(600, 959)
100%

— Water quality classification

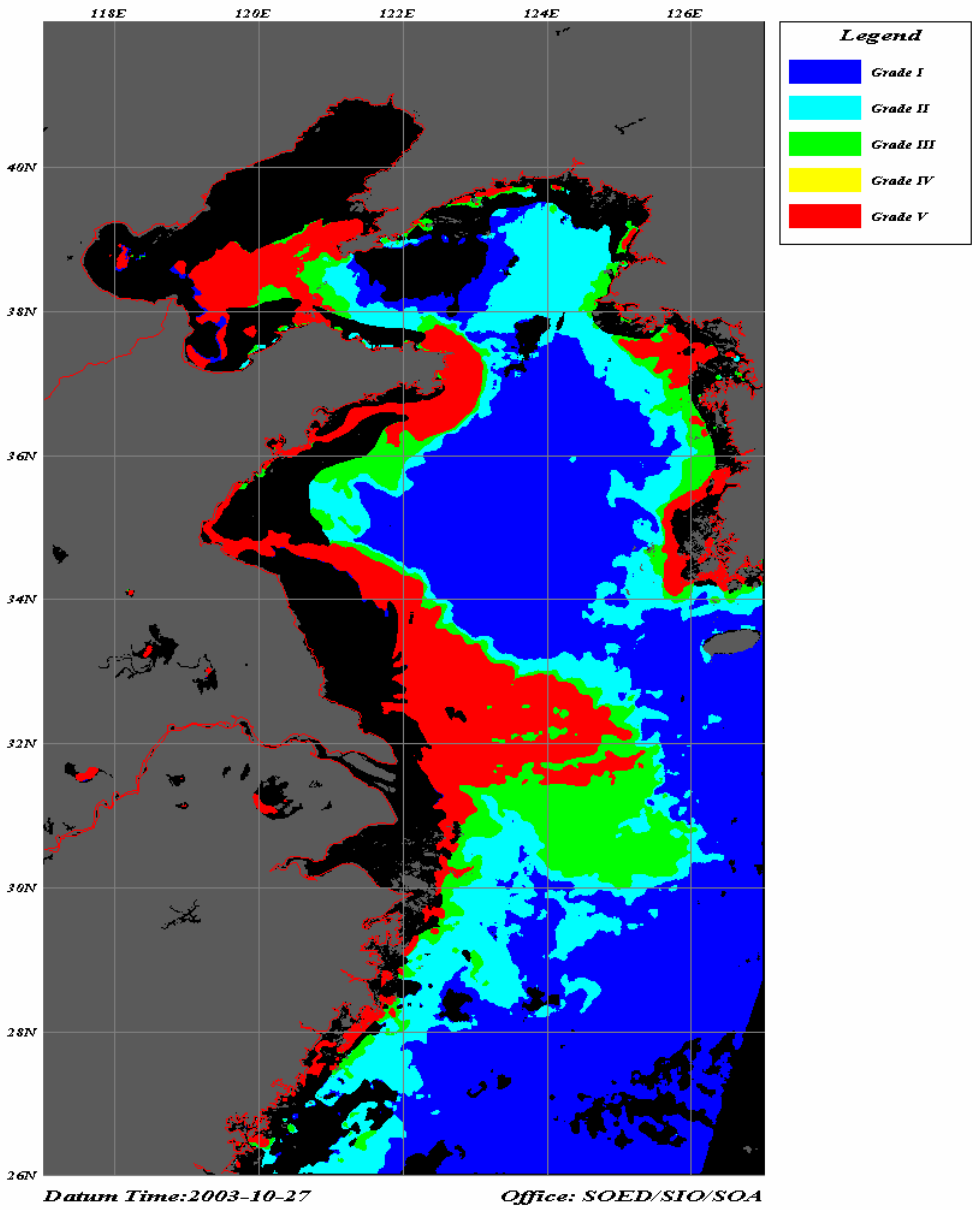


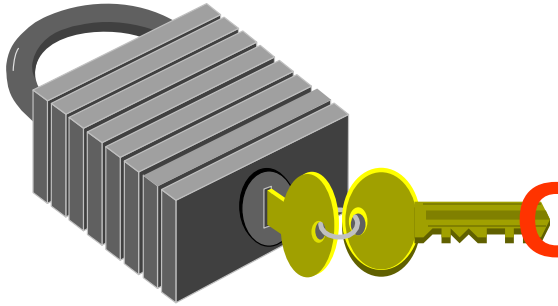
— Water quality classification





Satellite-derived Water Quality Classification

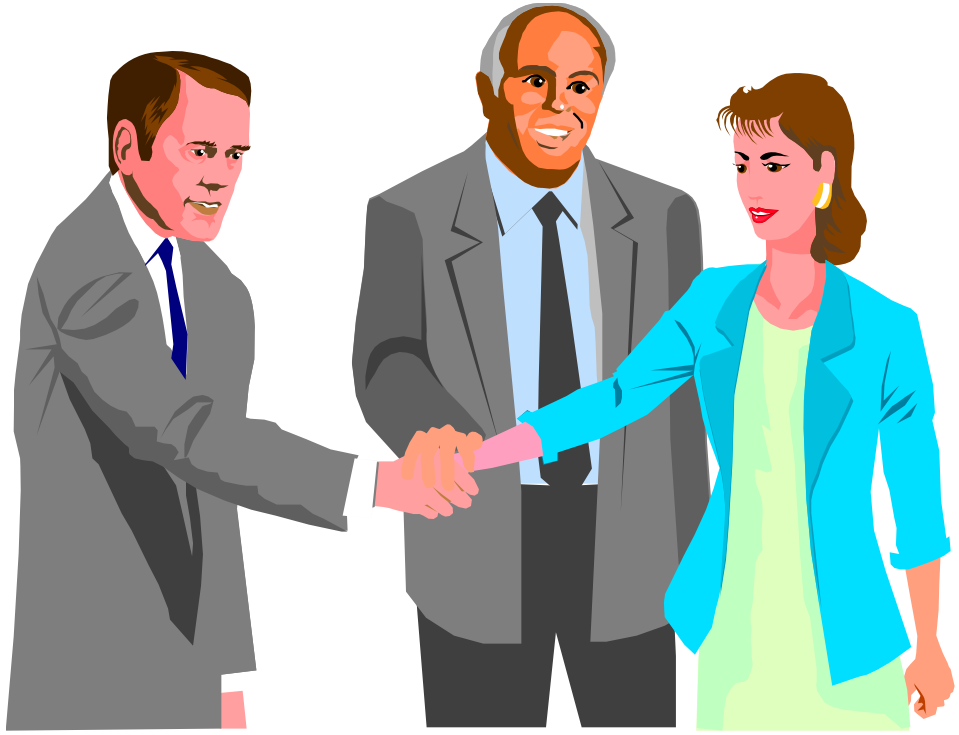




Conclusion

* **The properties of COCTS/HY-1B is operation since May,2007.**
* **The radiance of COCTS/HY-1B needs to be calibrated and the calibrated data is reasonable for ocean color mapping.**
* **Marine Remote Sensing Data Application and Mapping Toolbox is useful for HY-1B data merger with other color data and its application, such as coastal water quality mornitering.**

Thanks



二所海洋水色遥感　Ocean Color RS Group，SIO, SOA