Earth Observation System and its application to disaster management and emergency response in China

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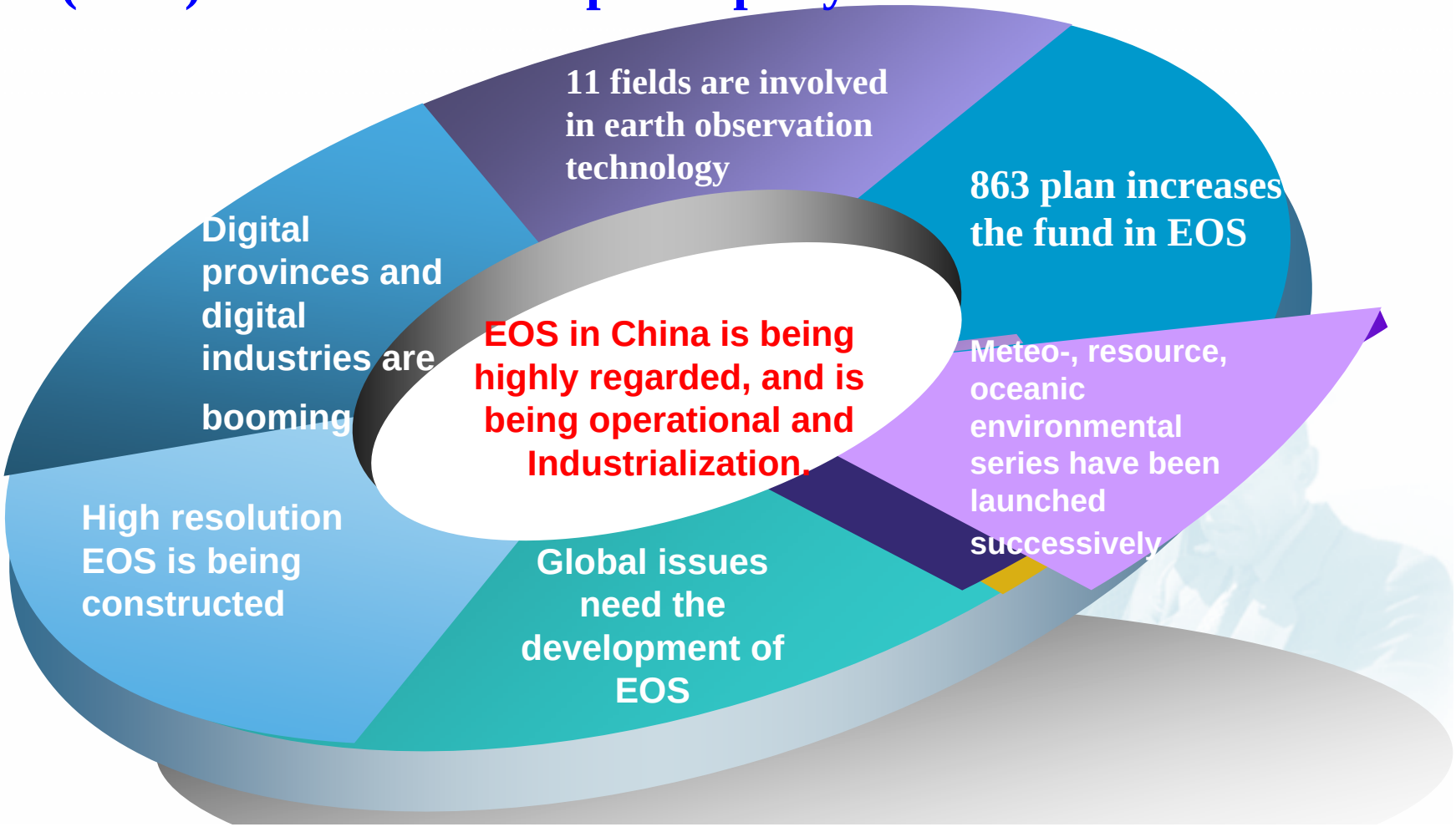
After many years of hard-work, Chinese Earth Observation System (EOS) has been developed rapidly



Contents


Earth Observation System in China

Already launched

FY -1/2/3

HY-1A/1B/2A

HJ-1A/1B

CEBERS-01/02/02B, BJ-1

Will be launched

FY-4

HY 2B/3A

CBERS 02C/03/04, ZY-03

Gravitational Satellite

HJ (4+4)

High-resolution Earth Observation System

In Researching

Seismo-Electromagnetic Satellite

Forming Five Major Abilities

- Strong design ability
- Advanced manufacturing ability
- Complete test ability
- Reliable launch ability
- Effective TT&C management ability

Now China's space industry has formed a complete system


Meteorological Satellites

FengYun(FY)meteorological satellites

already launched:

- FY-1 sun-synchronous orbit meteorological satellite series
  FY-1A/B/C/D: weather forecasting; climate research; environmental monitoring.
- FY-2 geostationary orbit meteorological satellite series
  FY-2A/B/C/D/E: spatial environmental monitoring； cloudy 3D monitoring.
- FY-3 sun-synchronous orbit meteorological satellite series
  FY-3A/B:global climate and environment monitoring; fine monitoring; all spectrum monitoring.

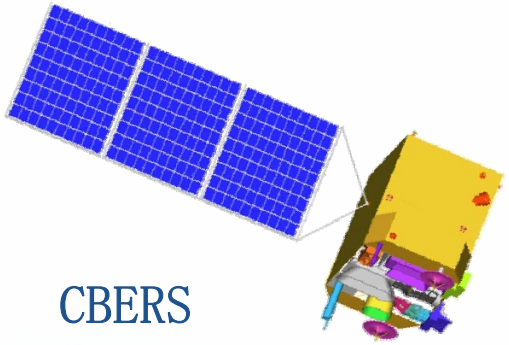
will be launched:

- FY-4 second generation geostationary meteorological satellite
  It's scheduled to be launched in 2015.
  Small-scale weather systems monitoring , lightning monitoring, extreme ultraviolet and X-ray solar observation, space weather monitoring and atmospheric vertical detection and microwave detection solving high track 3-D remote sensing.


Resources Satellites

Earth resources satellites

To Monitor flood, earthquake, coast, debris flow, Typhoon, forest fire, water pollution et al.



CBERS

already launched:

- First generation: CBERS-01/02
  - CBERS-01 (launched in 1999.10.14)
  - CBERS-02 (launched in 2003.10.21)
- Second generation: CBERS-02B (launched in 2007.09.19)

will be launched:

- CBERS- 02C/03/04 satellites
- high-resolution three-dimensional mapping satellite(ZY-3)

Image of Yellow River Delta taken by CBERS


Environment and Disaster Reduction Satellites

Chinese Environment and Disaster Monitoring and Forecasting Small Satellites Constellation

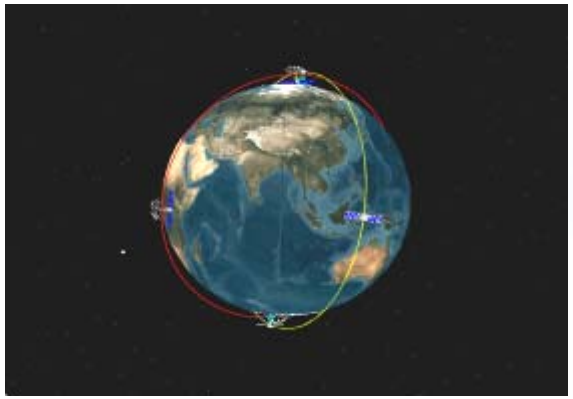
TASK: Disaster monitor and forecast; Environment monitor and forecast

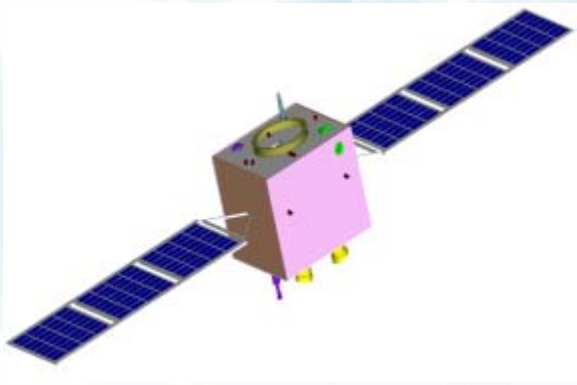
already launched :2 optical satellites(HJ-1A, HJ-1B)

- HJ-1A (launched in 2008.09.06)
- HJ-1B (launched in 2008.09.06)

under development: HJ 4+4 satellites

Basing on HJ-1A and 1B, 2 optical satellites and 4 SAR satellites will be launched.






Ocean satellites

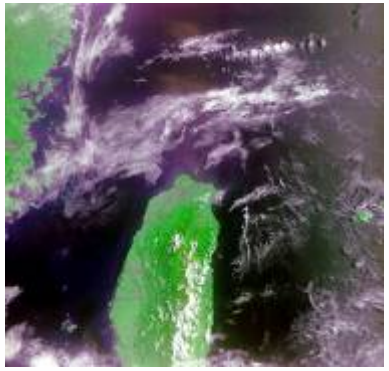
Ocean satellites HaiYang(HY)

already launched:

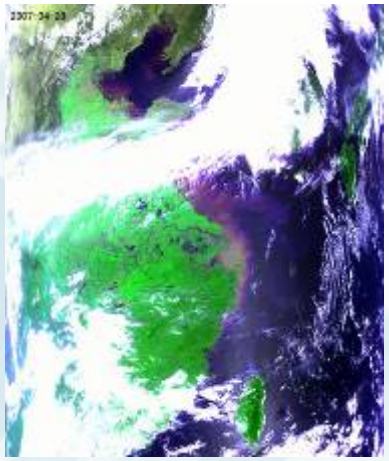
- HY-1A (launched in 2002.05.15)
  - for the purpose of oceanic color detection.
- HY-1B (launched in 2007.04.11)
  - HY-1A 's subsequent.
  - mainly used to detect chlorophyll, suspended sediment, organic matter, sea surface temperature , dynamic changes of the coastal zone.
- HY-2A ocean satellite (launched in 2011.08.16)
  - mainly used to detect Sea wind field, Wave field and height, Ocean gravity field, Ocean circulation, Sea surface temperature field.

will be launched:

- HY-2B/3A



First track image from HY-1A CCD camera.



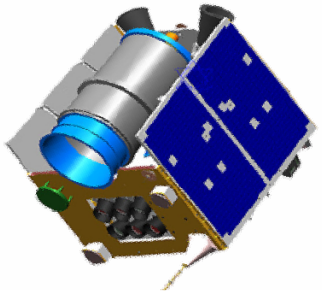
First track image from HY-1B in 2007.04.20.


Beijing-1 Small Satellite

Beijing-1 (launched in 2005.10.27)

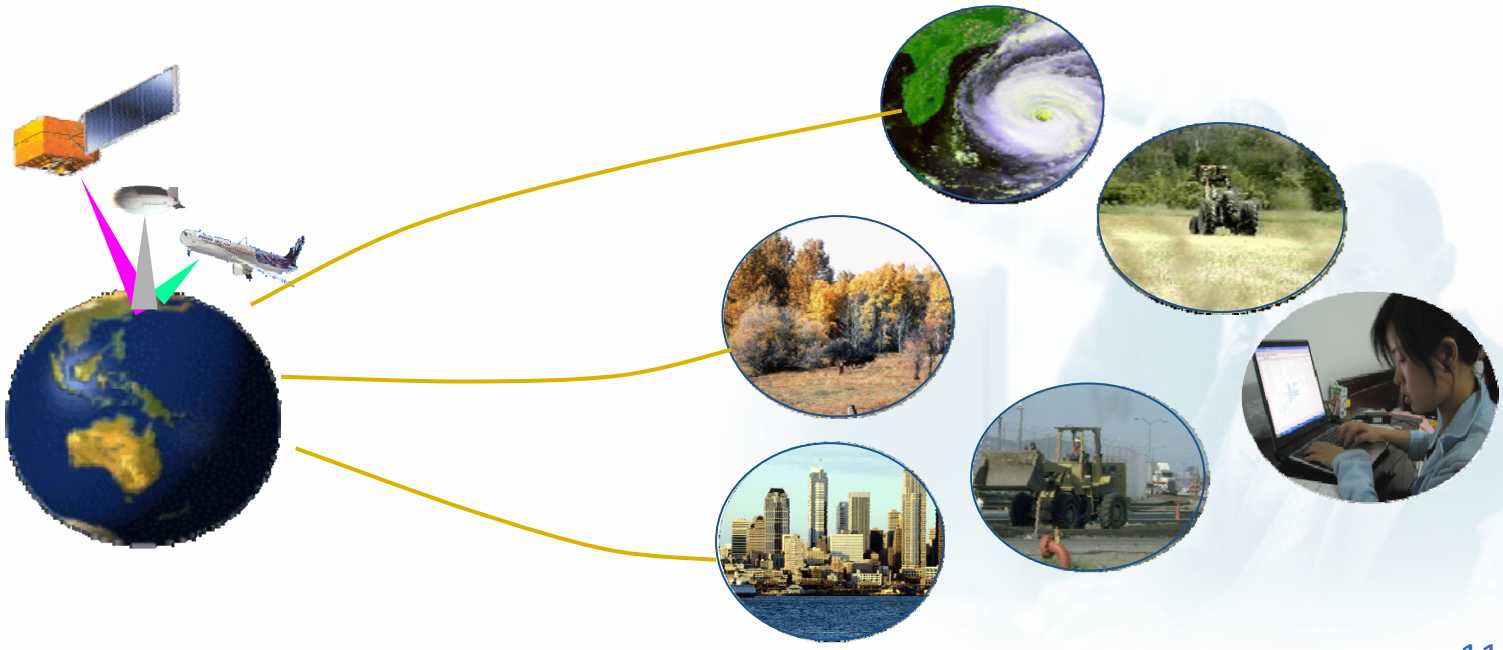
- the fifth satellite of International Disaster Monitoring Constellation (DMC).
- jointly developed by China and the UK Surrey Satellite Technology Co. Ltd..
- multispectral camera with a high resolution panchromatic imager.
- provide information on agriculture, water resources, environment and disaster monitoring throughout China.

	Mass (Kg)	lifetime (year)	Altitude (Km)	Inclination	payload			
					camera	band	Swath Width	resolution
Beijing-1	160	5	686	97.87	CCD1	Panchromatic 1	24km	4 m
					CCD2	Multispectral 3	600km	32 m



High-resolution Earth Observation System of Systems

- China will develop high-resolution earth observation system based on the platform of satellites, aircraft and stratospheric airship in the next 10 years.
- It is planned to build a stable earth observation system and form a complete industry chain of earth observation applications in 2020.



Contents

2. Applications for Disaster Prevention and Mitigation

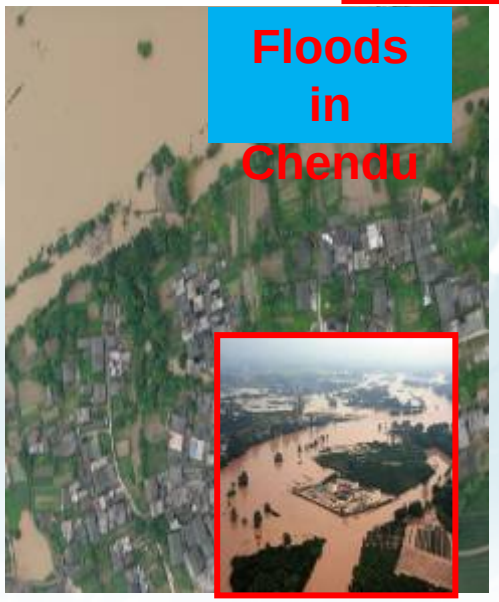

Over the past decade natural disaster has created direct economic in total loss surpassed 50.8billion US dollars in China.

Beichuan

Collapsed houses after the earthquake

Yushu

Mud-rock flows in Zouqu



Floods in Chendu

Natural Disaster Warning and Monitoring

Space technology

Disaster management

Pre-disaster

Disaster period

Post-disaster

Risk assessment

Early warning

Monitoring

Damage assessment

Support

prevention

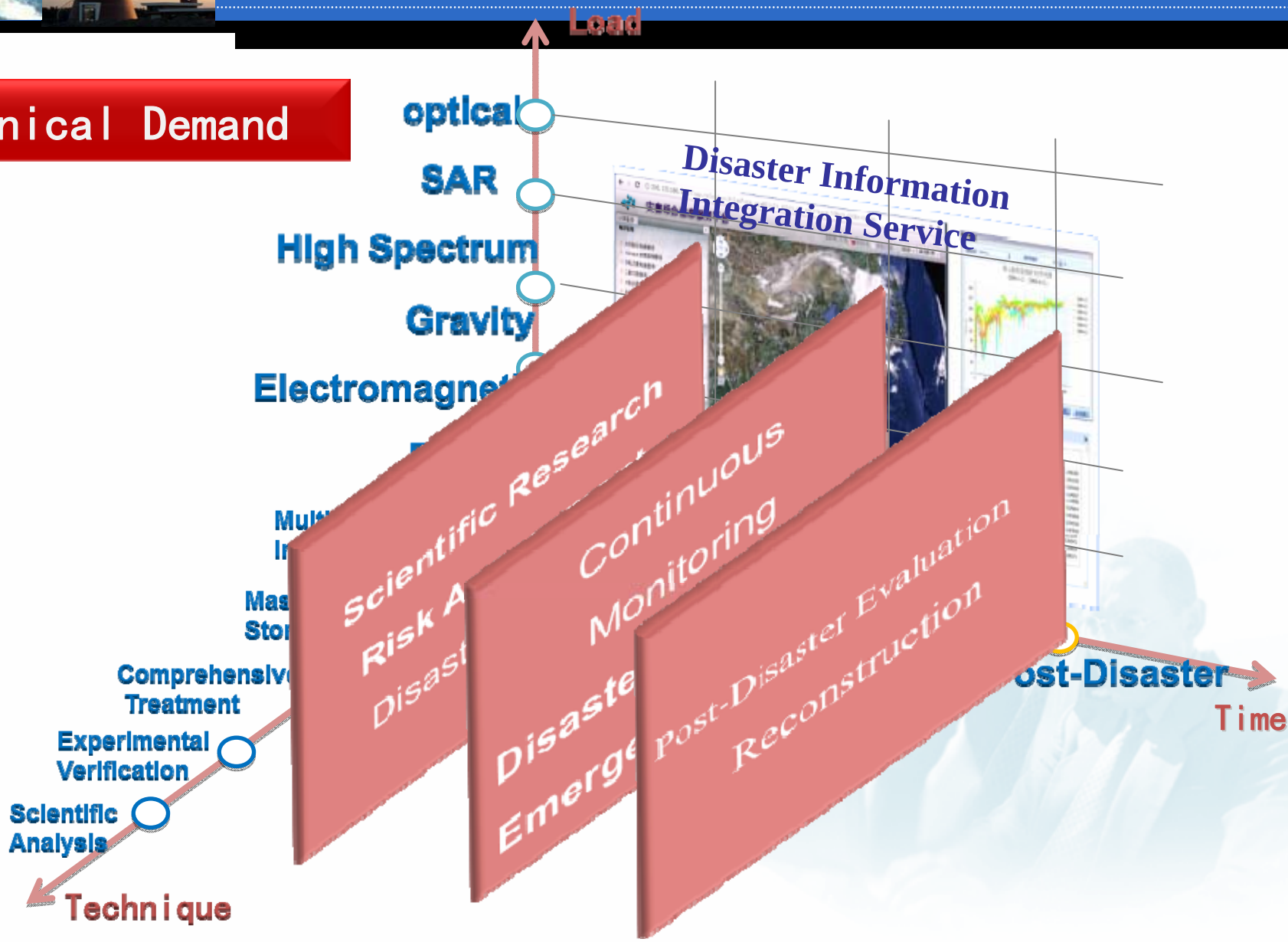
preparation

Emergency response

Reconstruction

Natural Disaster Warning and Monitoring

Technical Demand




Natural Disaster Warning and Monitoring

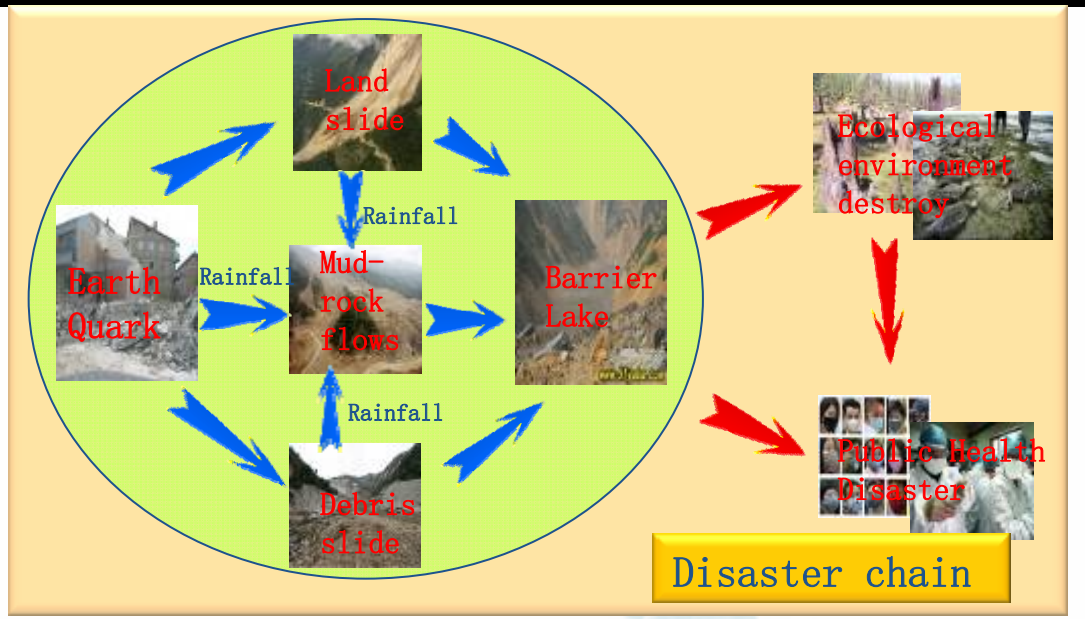
Requirement analysis

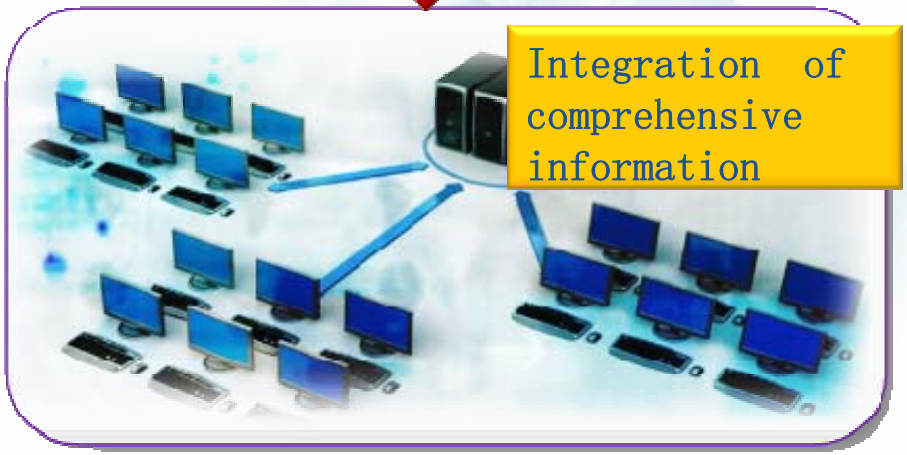
spatial information technology in each stage of disasters

Before disaster	During disaster	After disaster
Background investigation, acquisition of precursory anomaly, continuous monitoring, predicting alarm	**Emergency response, monitoring and warning, rapid report of disaster situation**	**Reconstruction after disaster**
•Remote sensing geophysical geometric information •Environment elements background •Gas abnormal of earthquake fault •…	•Monitoring of water variation characteristics •Monitoring of forestry damage characteristics •Detection of secondary disaster change •Rescue path …	•Assistant analysis and evaluation of geological environment •Assistant analysis and evaluation of ecological environment impact •Assistant analysis and evaluation of water environment impact …


Natural Disaster Warning and Monitoring

- **Earthquark,landslide,mud-rock flows occurr often together and form disaster chain, it is necessary to integrate use of information for disaster emergency and rescue.**

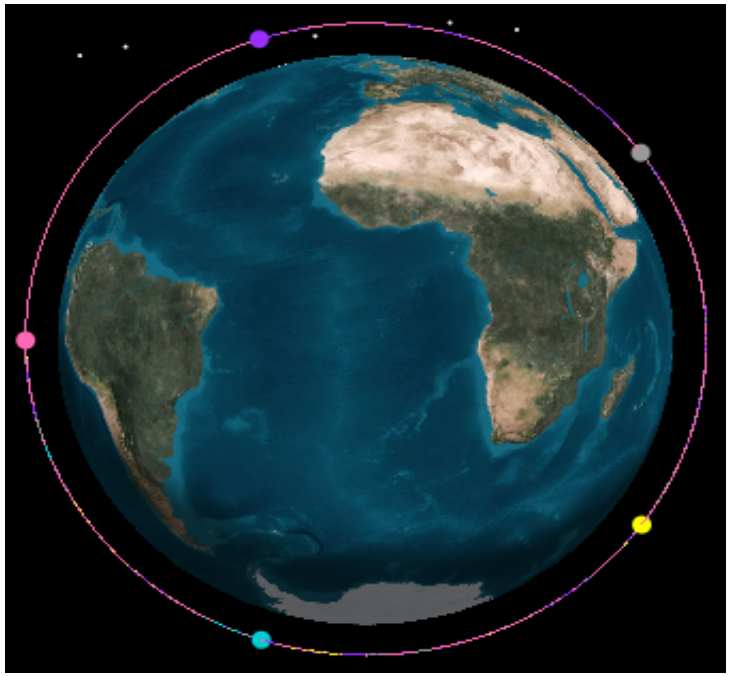


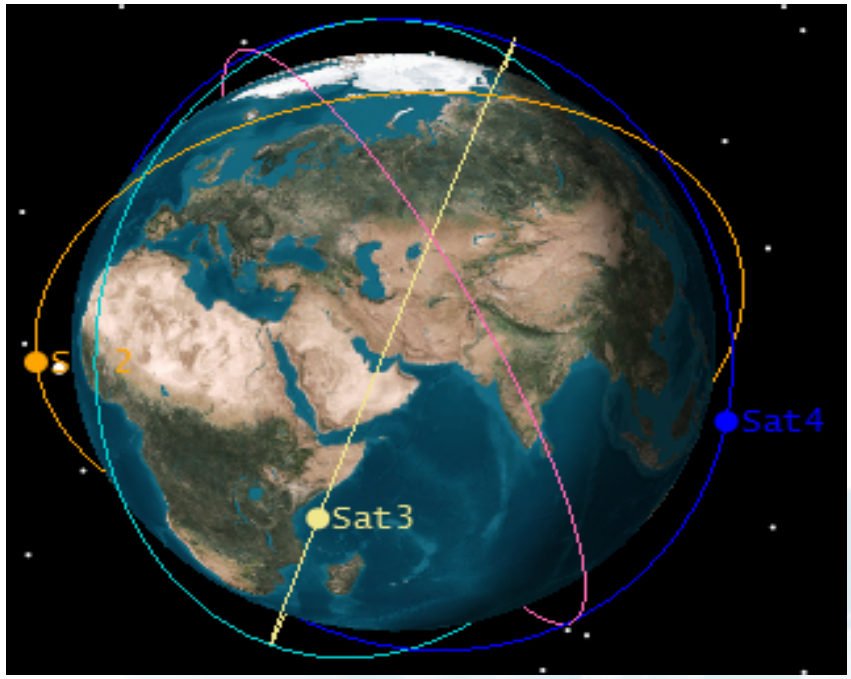


Pre-disaster period

Simulation of Satellite orbit

support for the design of disaster satellite





Orbit simulation of five satellites


Simulation of Images

Target and background databases with spatial and spectral variability (clutter)

Thermodynamic Optical Properties

Atmospheric Database

Sensor Model

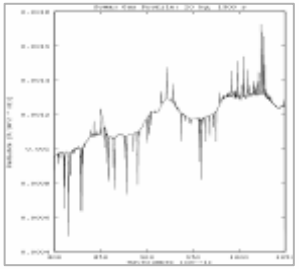
Object Geometry

Weather Database

Radiometry Model

simulation

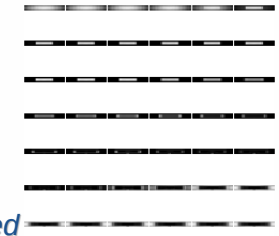
Thermal Model



Fully-spectral radiation propagation

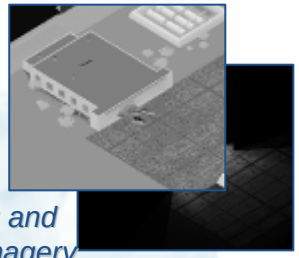
Broadband, multi-, hyper- or ultra-spectral imagery

Simulated Data Products



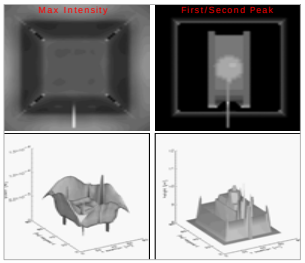
Range Gated LADAR

Hyperspectral Imagery and Target Maps

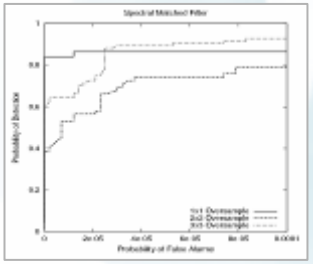


Thermal IR and Low-Light Imagery

Simulated Data Exploitation Products



Obscured Target Detection



Sub-Pixel Detection Performance (ROC curves)

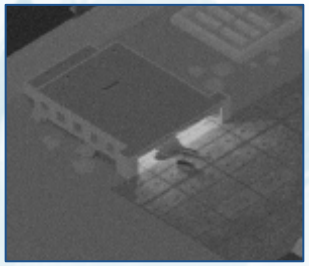
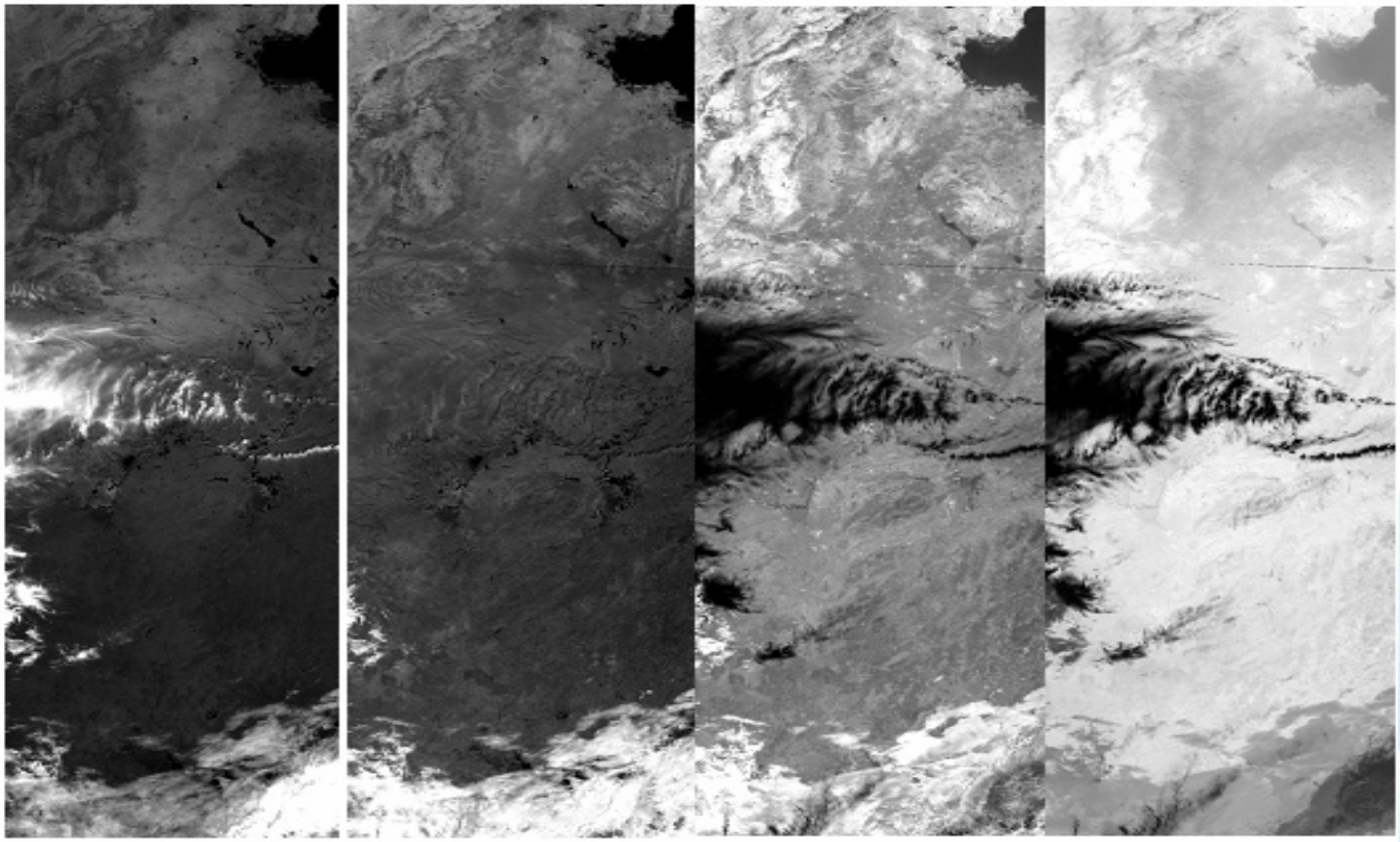


Image Fusion Demonstrations

Simulation of Images

Using MODIS image simulate HJ-1A data

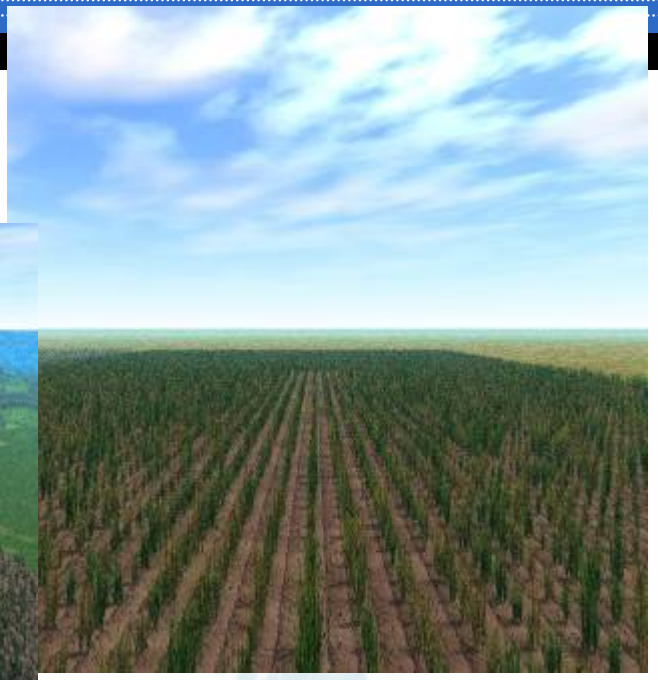
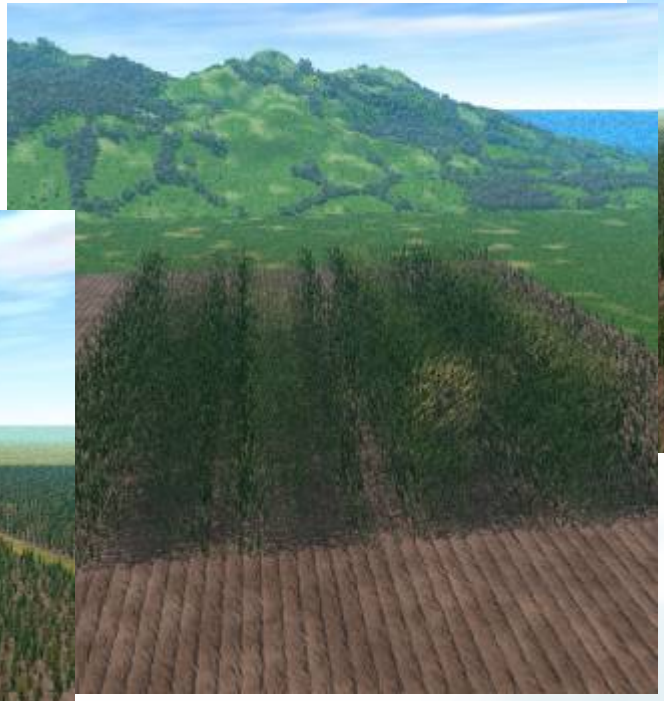
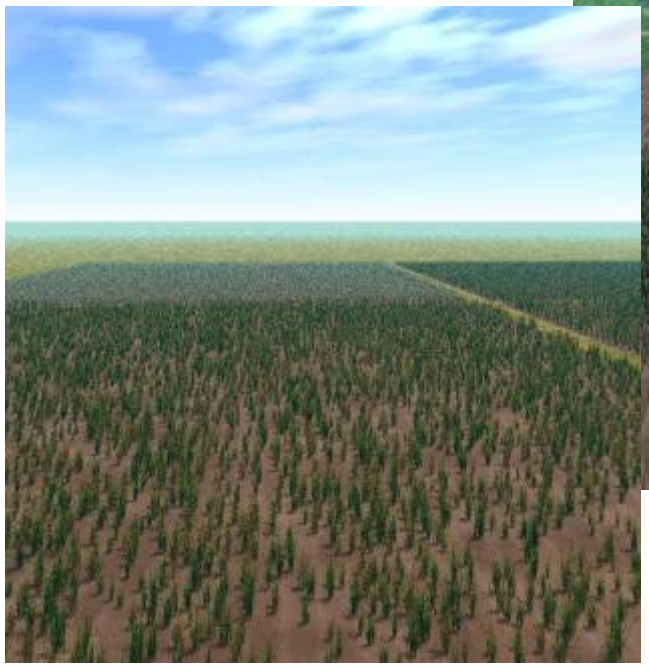


(a) 0.75-1.10um 分辨率：150m　(b) 1.55-1.75 um 分辨率：150m　(c) 3.50-3.90 um 分辨率：150m　(d) 10.5-12.5 um 分辨率：300m

利用 MODIS 模拟环境小卫星红外四个通道数据


Simulation of Images

target scene simulation

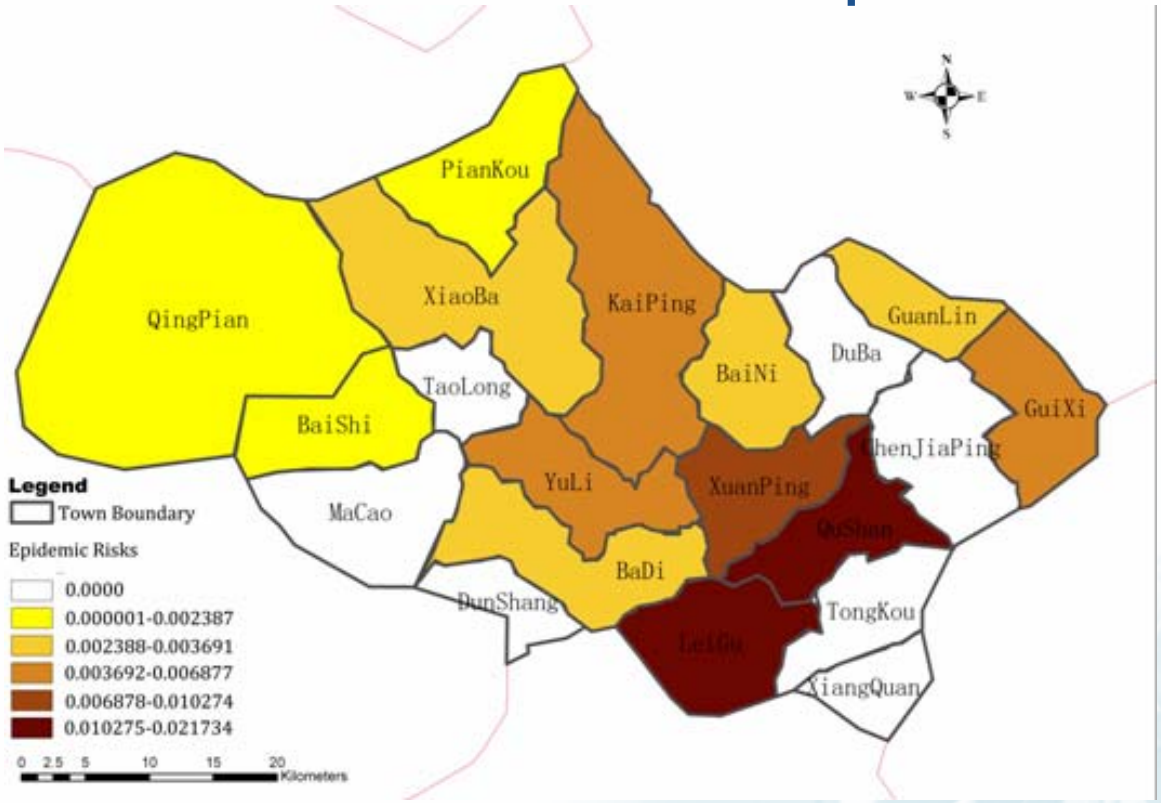
HJ-1 Image and Simulation Application

Risk Assessment

comprehensive risk distribution map of national natural disaster

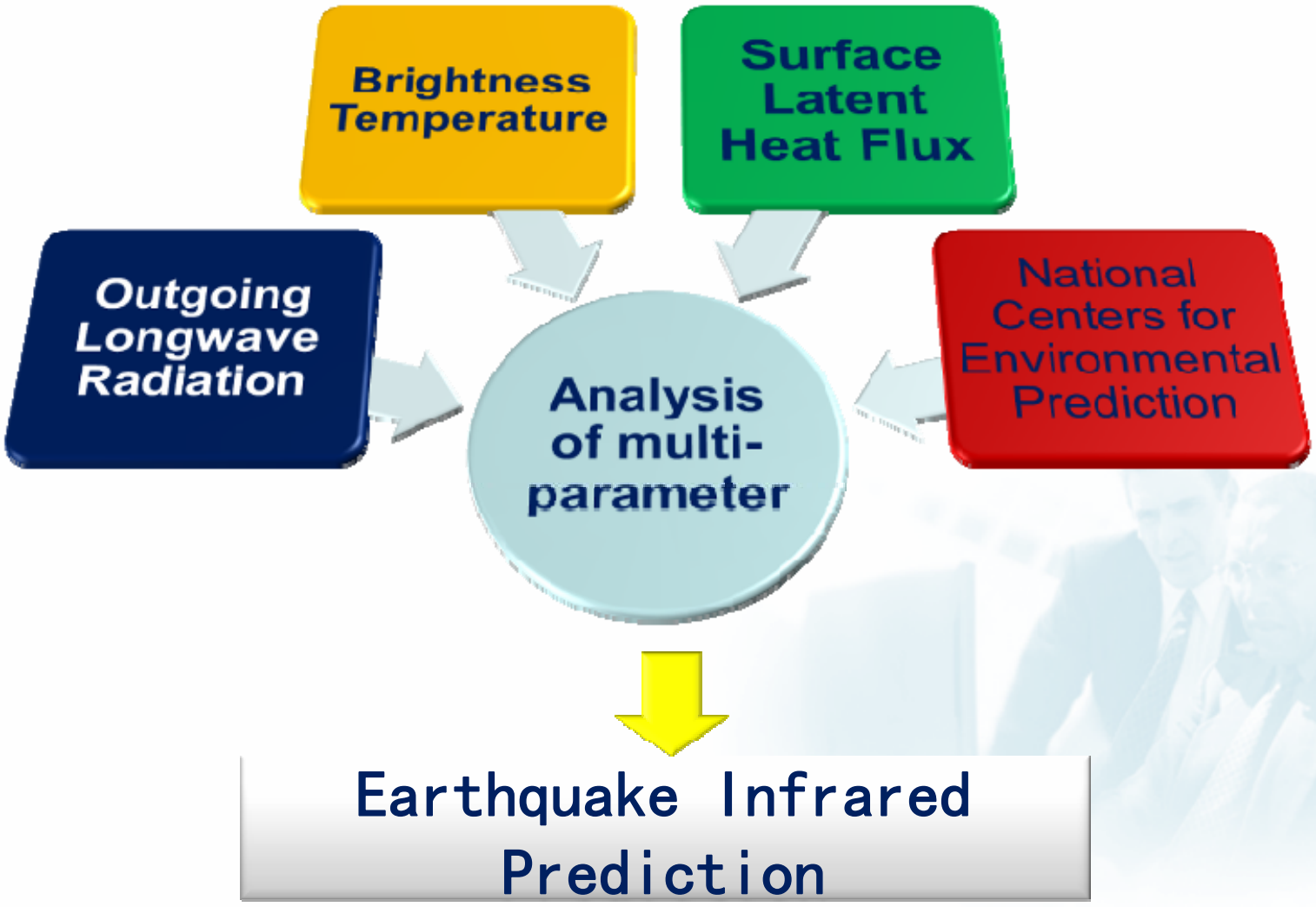
Risk assessment

Epidemic risk assessment after Wenchuan earthquake



Epidemic risk analysis after Wenchuan earthquake with remote sensing

Early warning

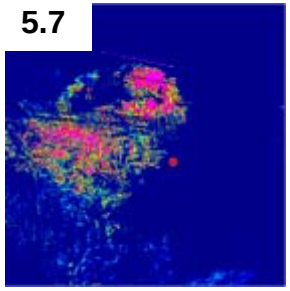


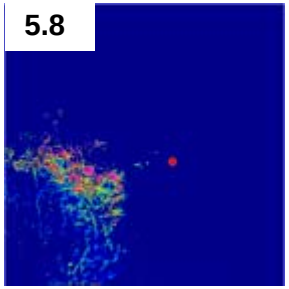
The research of five major earthquakes

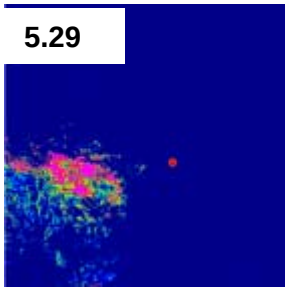
Earthquake Name	Time	Latitude	Longitude	Depth	Magnitude
Wenchuan	2008.5.21	31°	103.4°	14	8.0
Yushu	2010.4.14	33.1°	96.7°	33	7.1
We’nan	2006.7.4	38.9°	116.3°	19.3	5.1
Pu’er	2007.6.3	23°	101.1°	5	6.4
yutian	2008.3.21	35.6°	81.6°	33	7.3

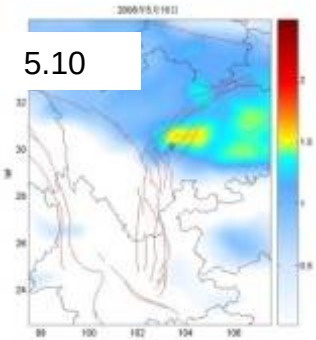

Multi-parameters Analysis of Wenchuan Earthquake

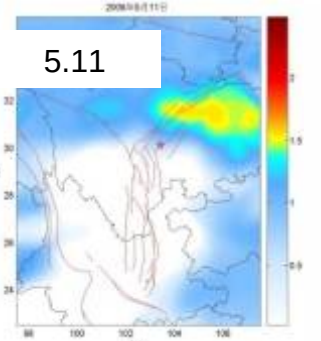
TBB **OLR（ Polar-orbiting）** **OLR（ Static -orbiting）** **SLHF** **NCEP**

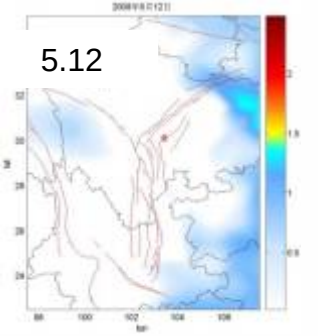


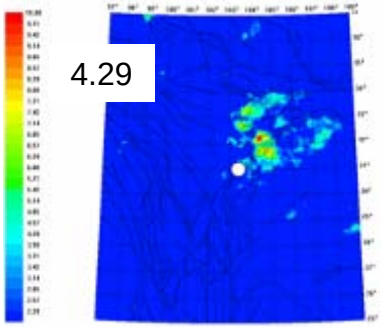


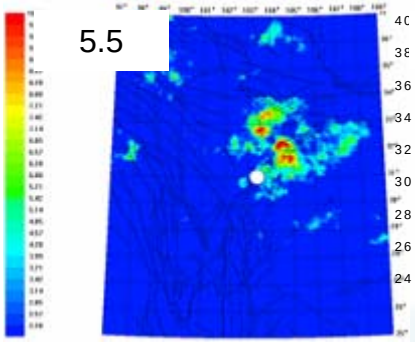


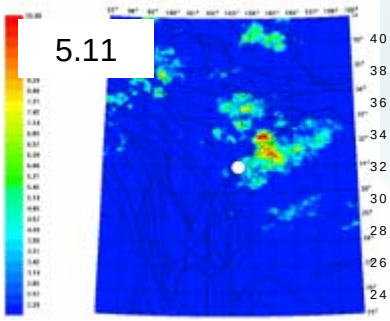


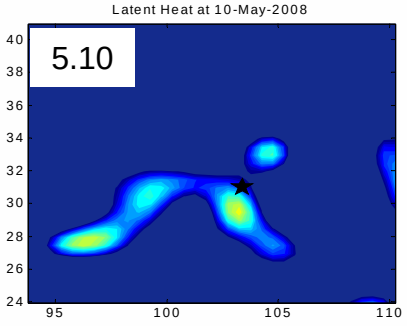


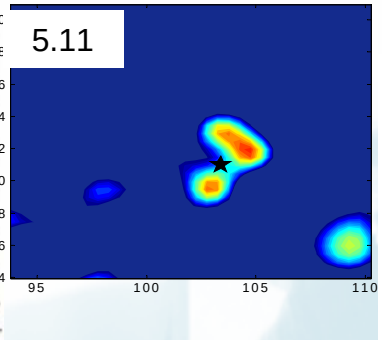


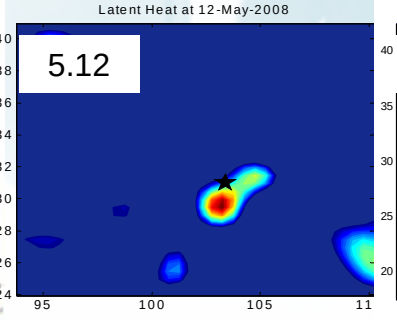


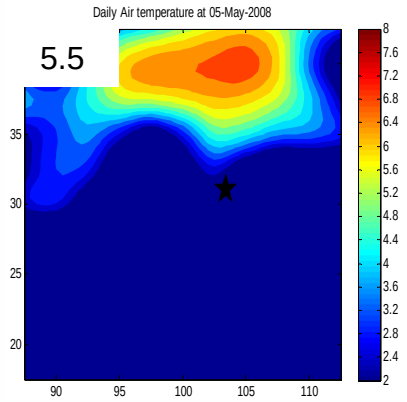


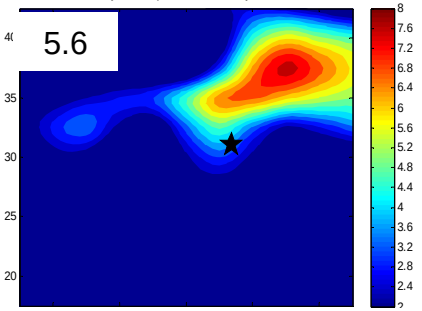


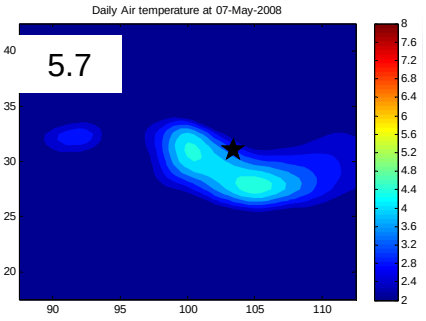






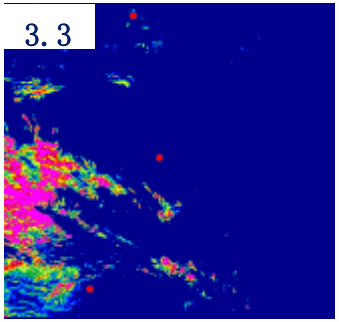


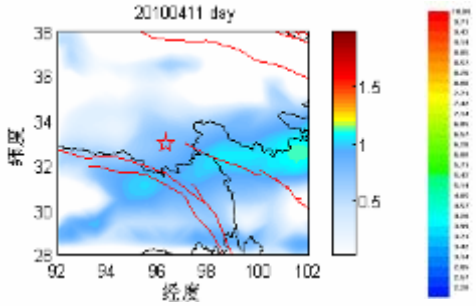


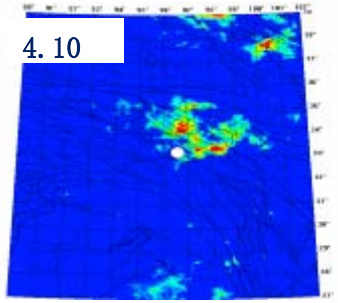


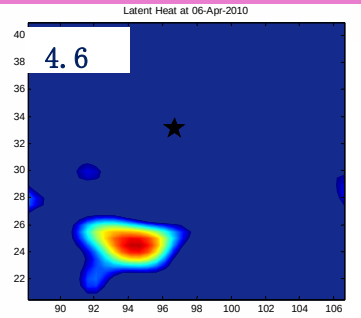

Multi-parameters Analysis of YUshu Earthquake

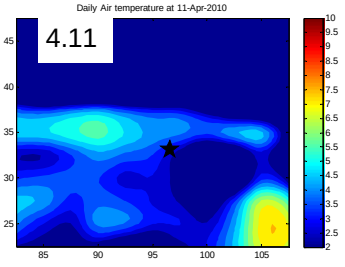
TBB **OLR（ Polar-orbiting）** **OLR（ Static -orbiting）** **SLHF** **NCEP**

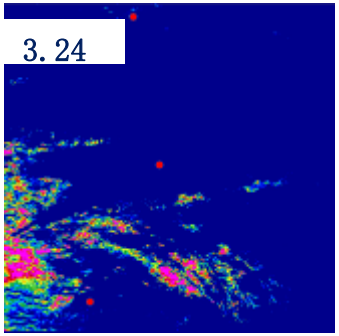


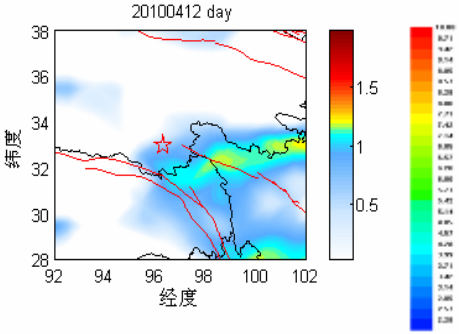


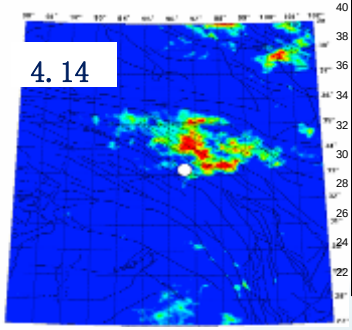


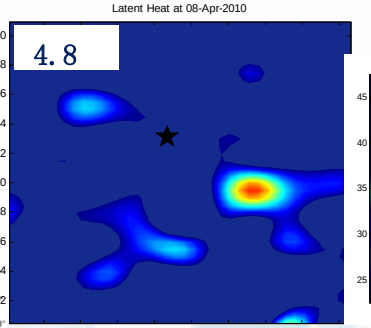


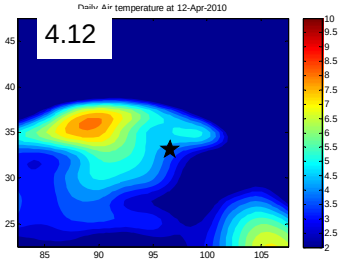


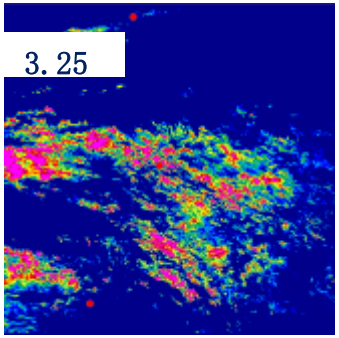


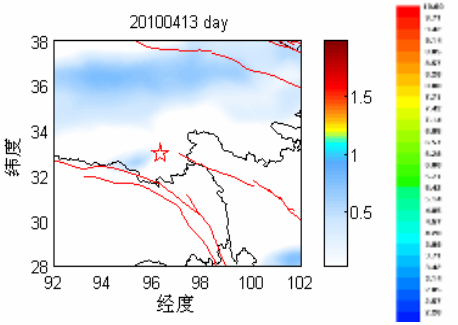


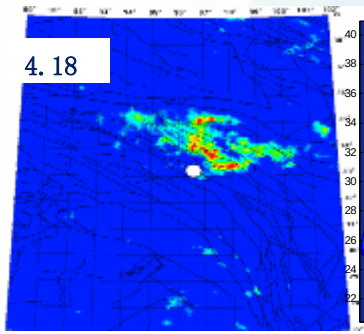


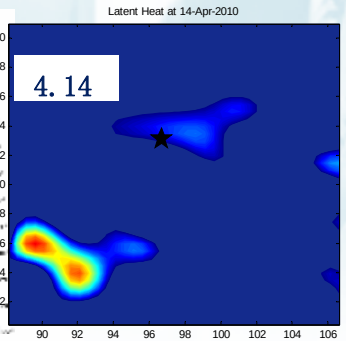


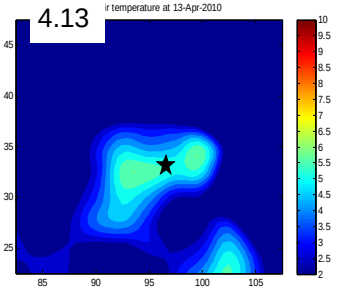






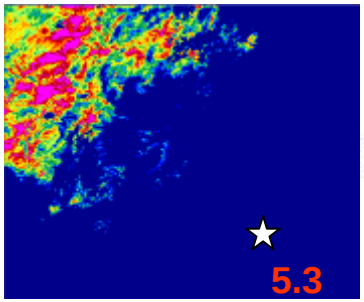


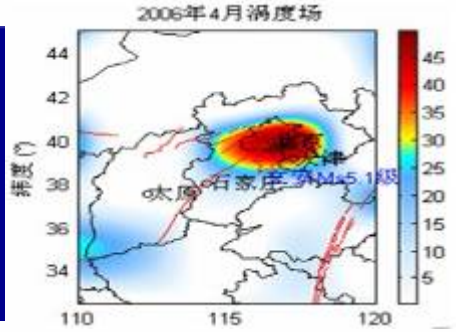


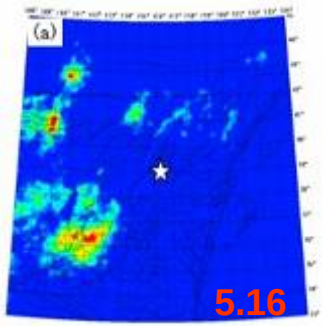


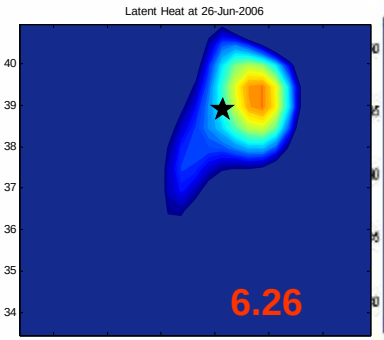

Multi-parameters Analysis of Wen'an Earthquake

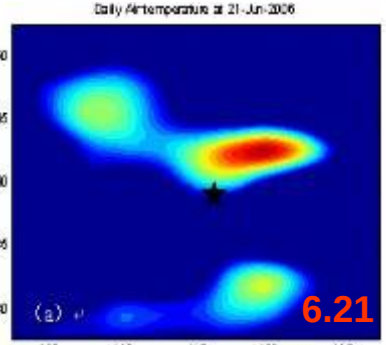
TBB	OLR（ Polar-orbiting）	OLR（ Static -orbiting）	SLHF	NCEP

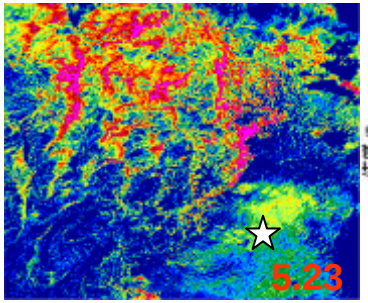


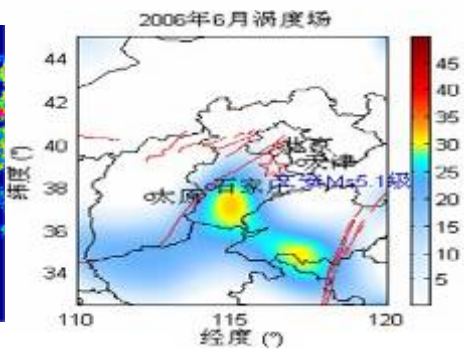


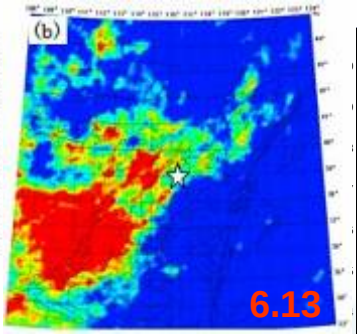


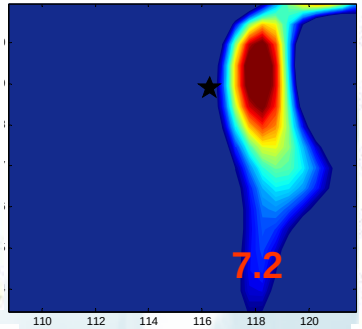


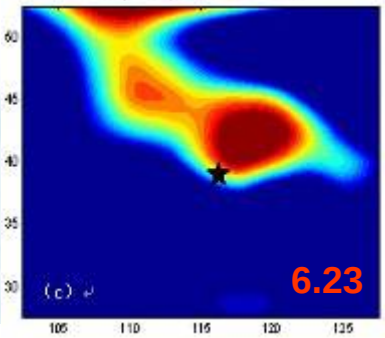


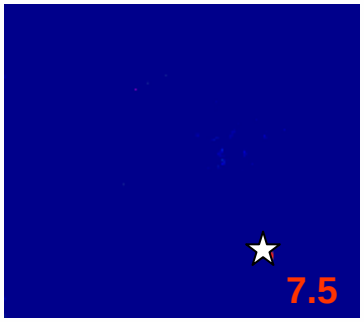


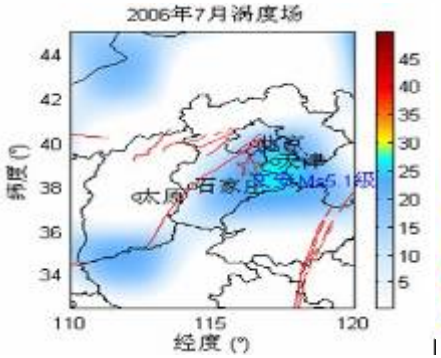


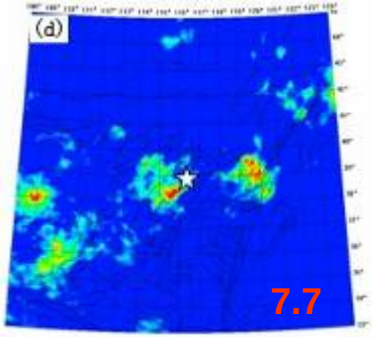


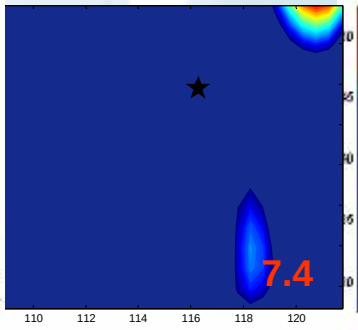


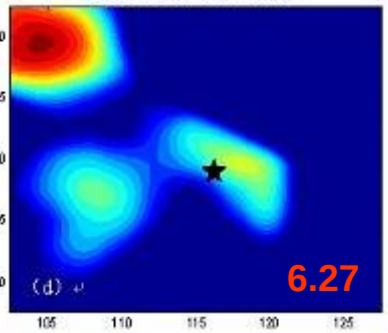






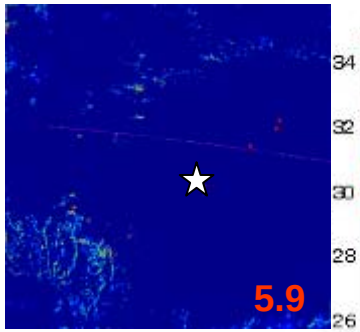


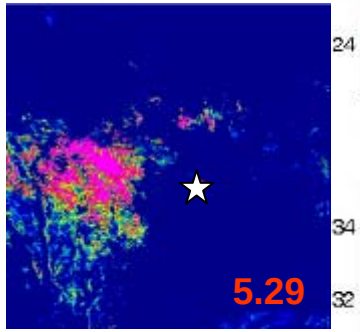


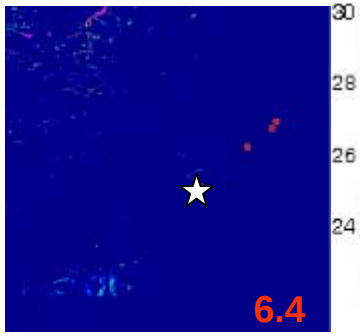


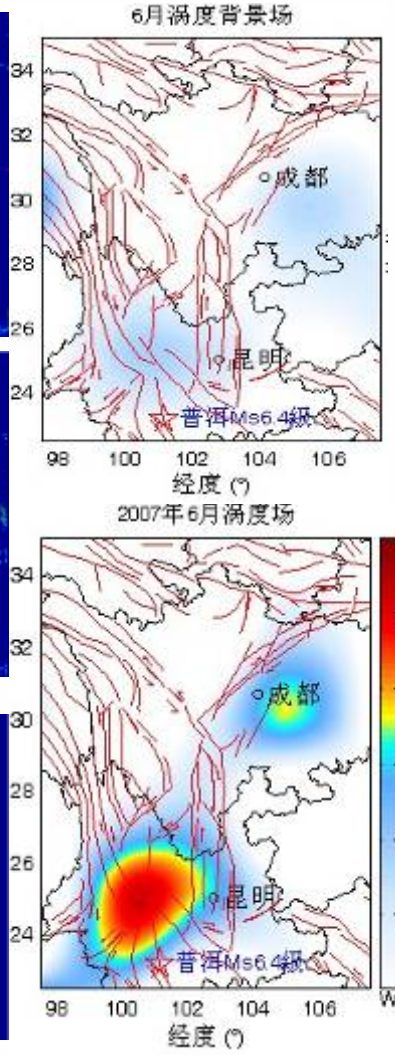

Multi-parameters Analysis of Pu'er Earthquake

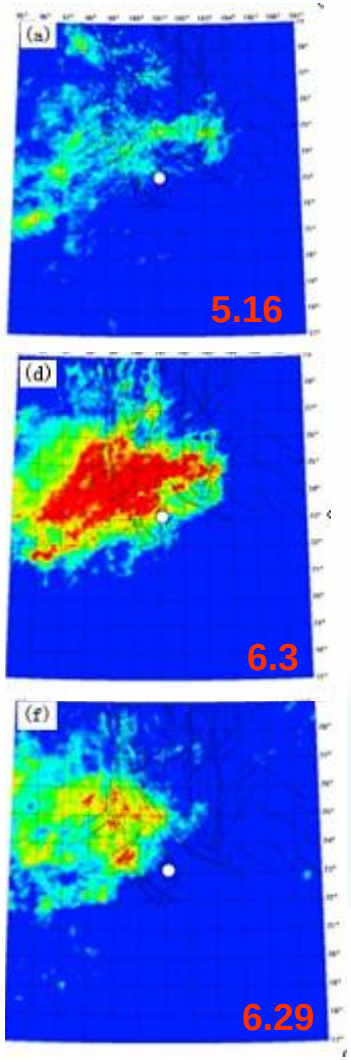
TBB **OLR（ Polar-orbiting）** **OLR（ Static -orbiting）** **SLHF** **NCEP**

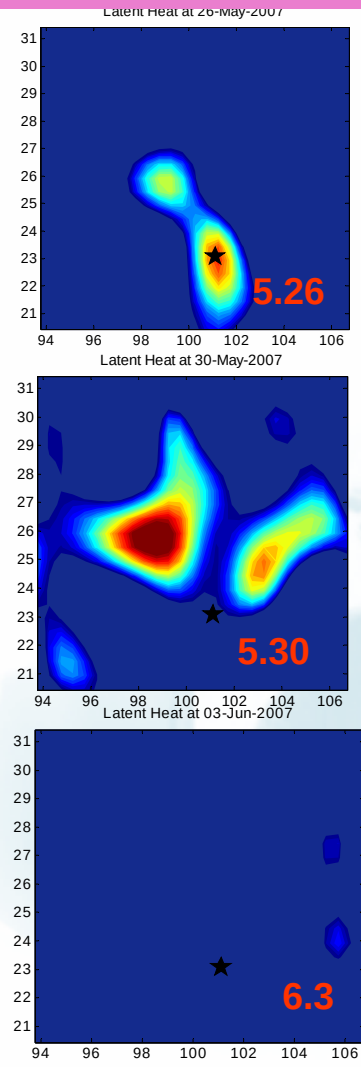


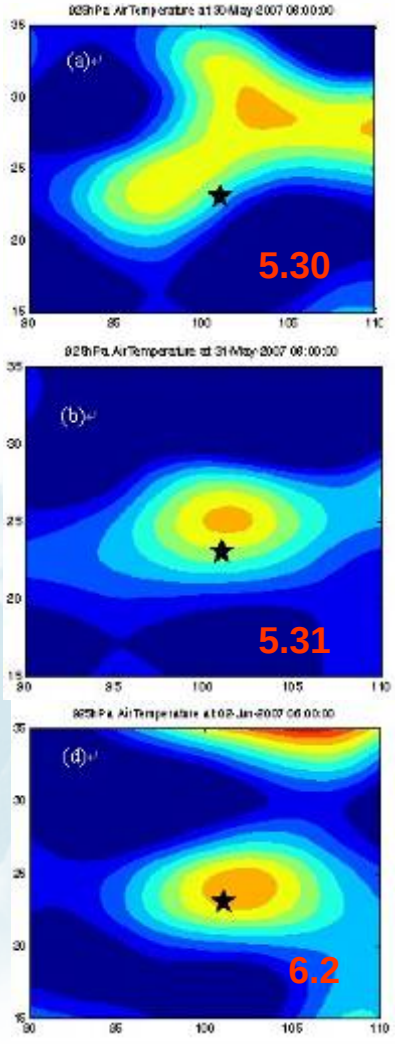






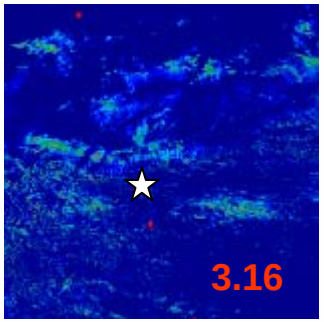


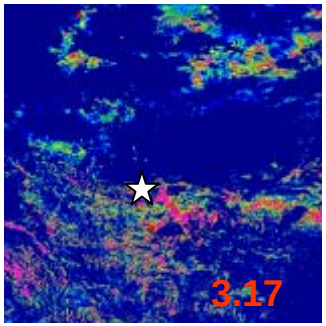


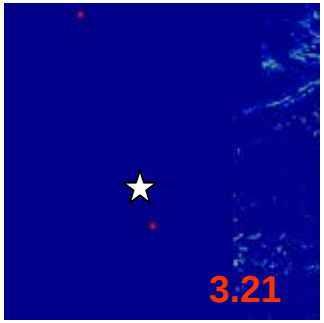


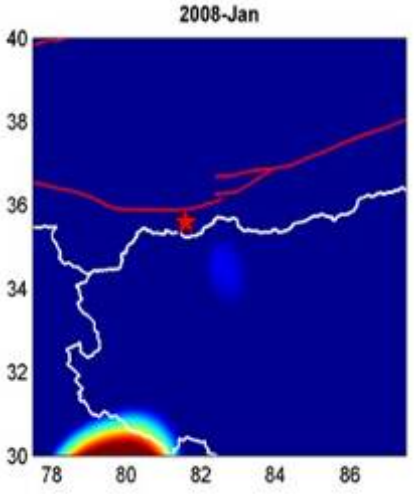

Multi-parameters Analysis of Yutian Earthquake

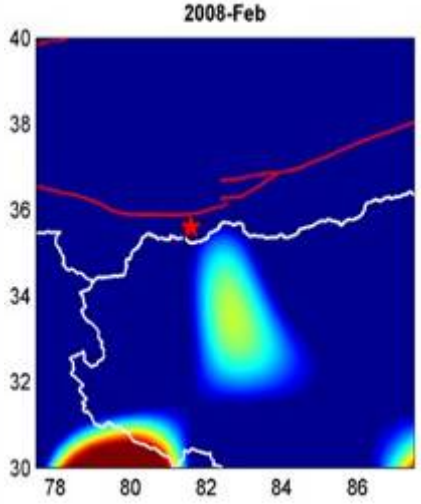
TBB **OLR（ Polar-orbiting）** **OLR（ Static -orbiting）** **SLHF** **NCEP**

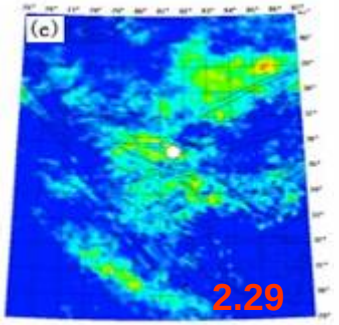


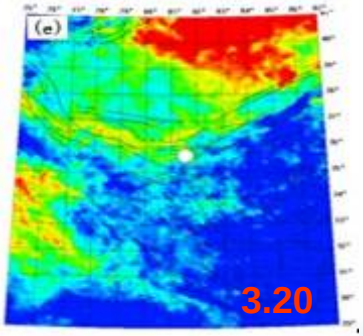


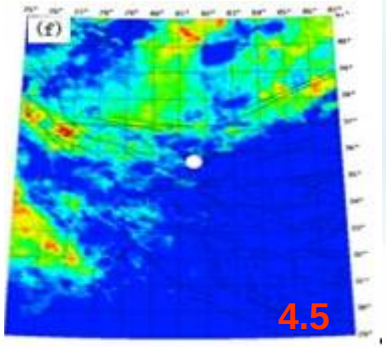


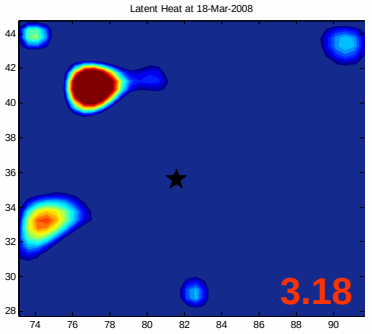


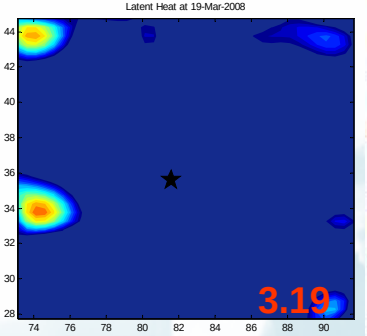


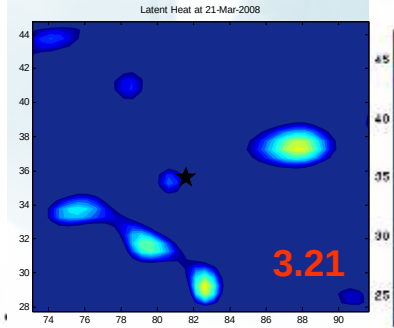


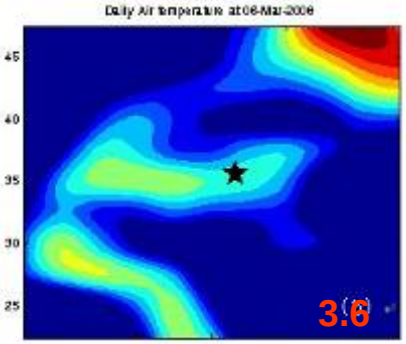


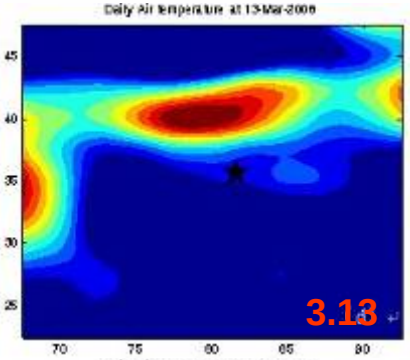


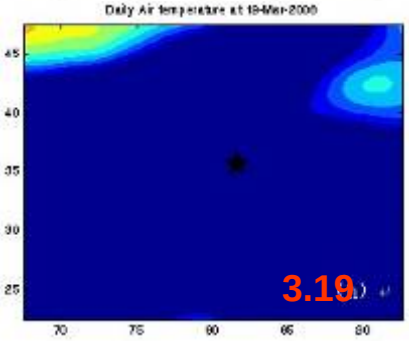












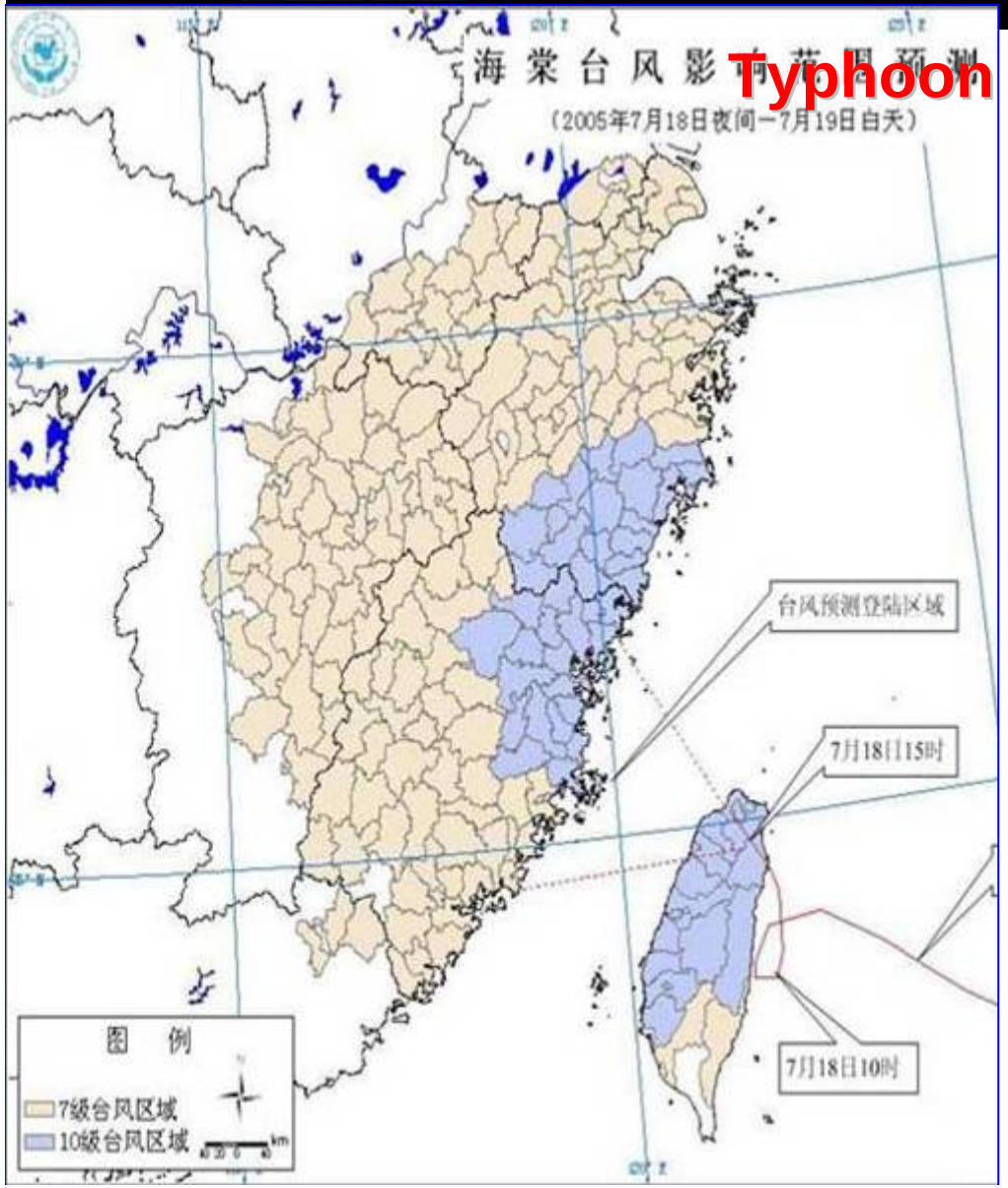

The results of the research

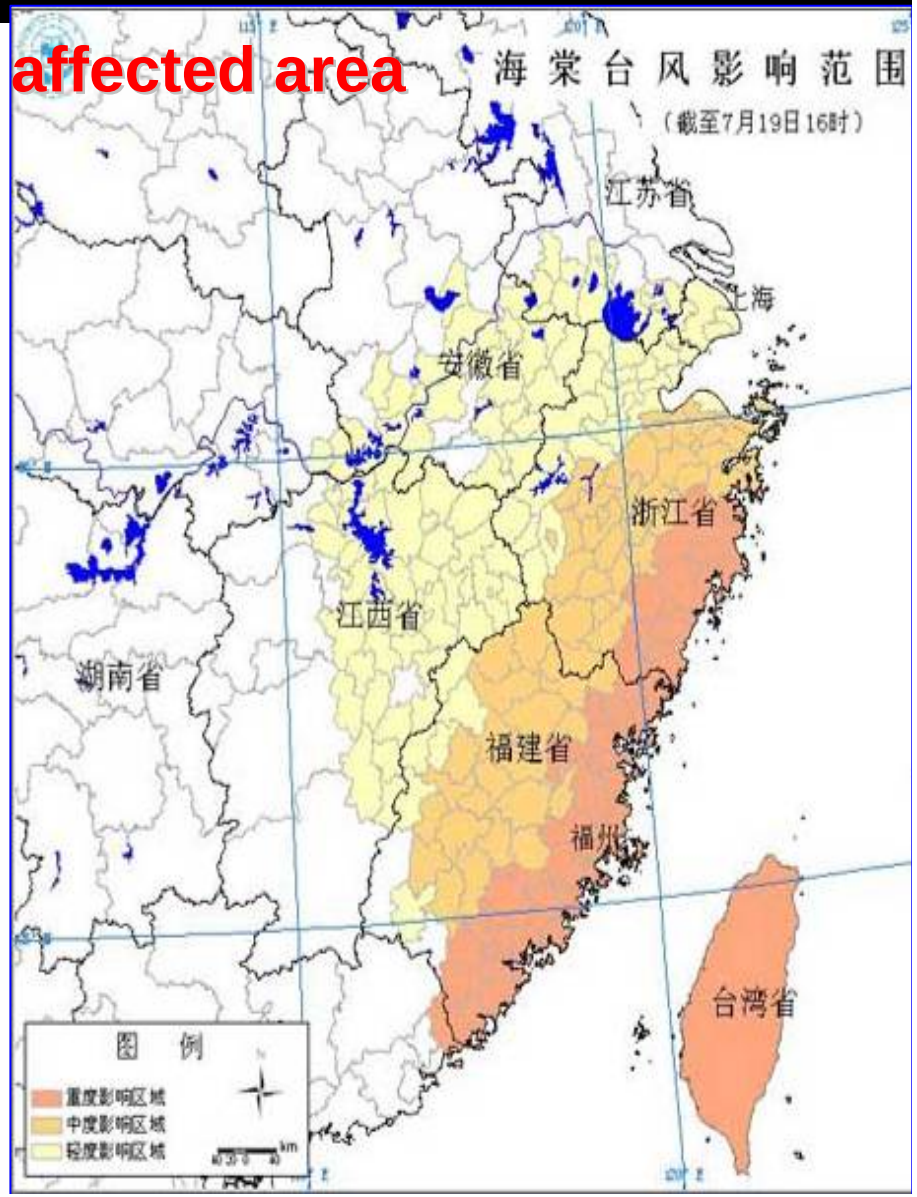
Parameter	Quantity	The probability of abnormal	Method	Time characteristics	Spatial Characteristics
OLR	115	47%	Background vorticity field	Generally 15D Before Earthquake	Spatial distribution of the isolated
TBB	23	65%	Brightness temperature offset value index	Several days before Earthquake	Abnormalities seen in the fracture zone around the epicenter
SLHF	95	77%	Eliminate the background field	Two weeks before Earthquake	Earthquake abnormal moves from migration to Epicenter
NCEP	94	62%	Temperature increment field	Generally 15D Before Earthquake	Earthquake Happens at the peak or near

The earthquake abnormal always appears before two weeks

Early warning

Typhoon affected area





Meteorological Disasters Monitoring

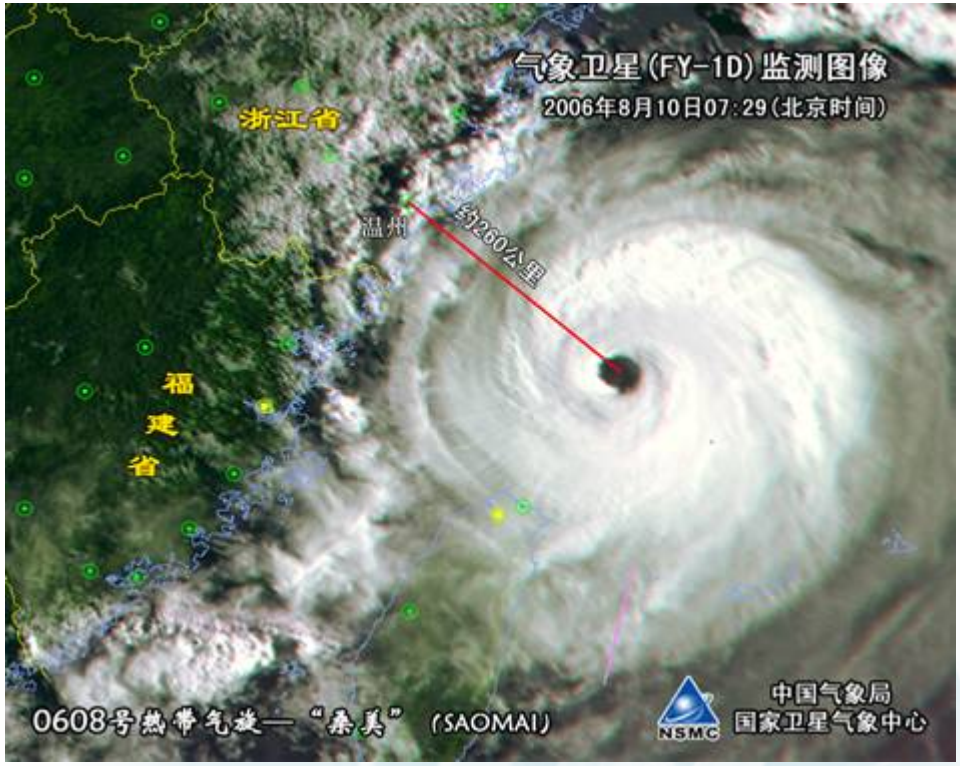
- Meteorological satellites data have been widely used in meteorological research, weather analysis and forecasting.

- Chinese large-scale drought, frequent floods, typhoons, as well as huge sandstorms, snowstorms and forest fires and so on are in observation and surveillance of China’s meteorological satellites.

Meteorological Disasters Monitoring

The process of Typhoon “Saomai” cross China observed by FY-1D satellite.

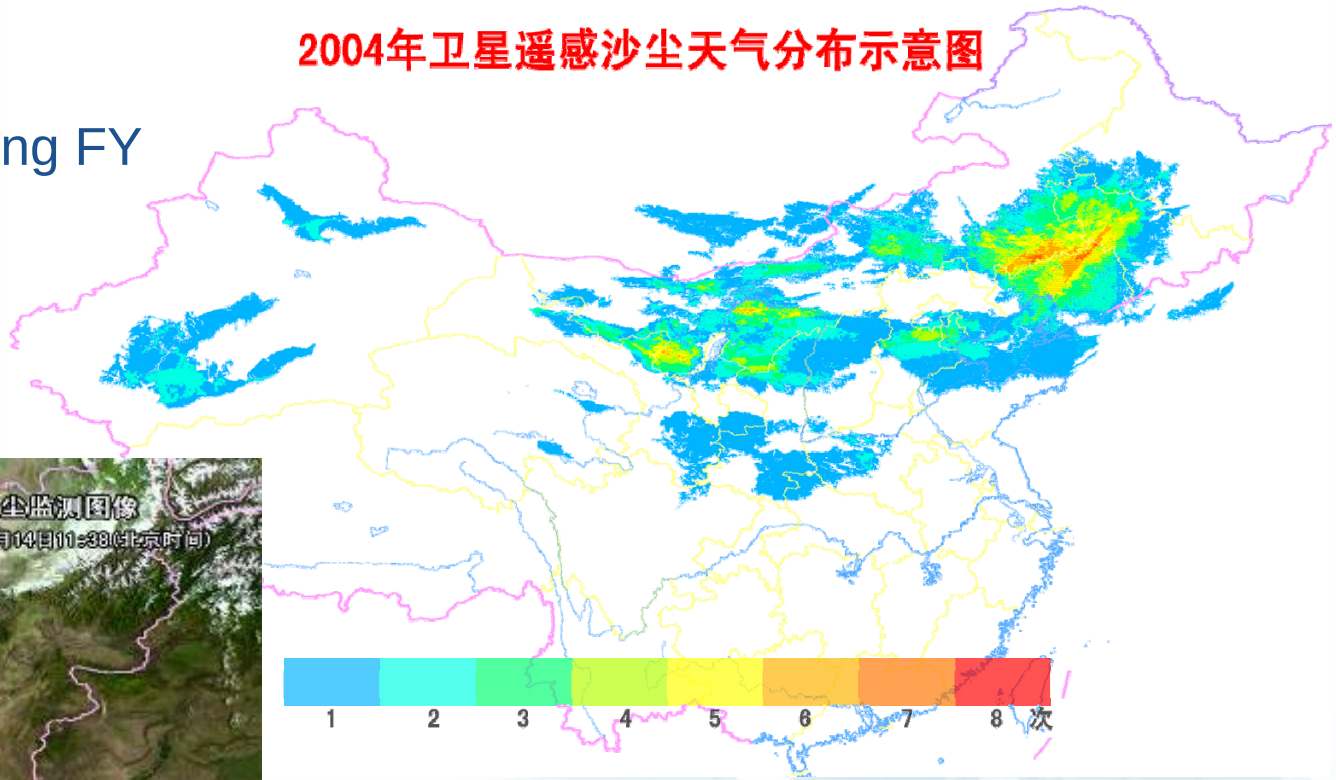
(a) Observed at 05:58 in 2008.08.09



(b) Observed at 07:29 in 2008.08.10

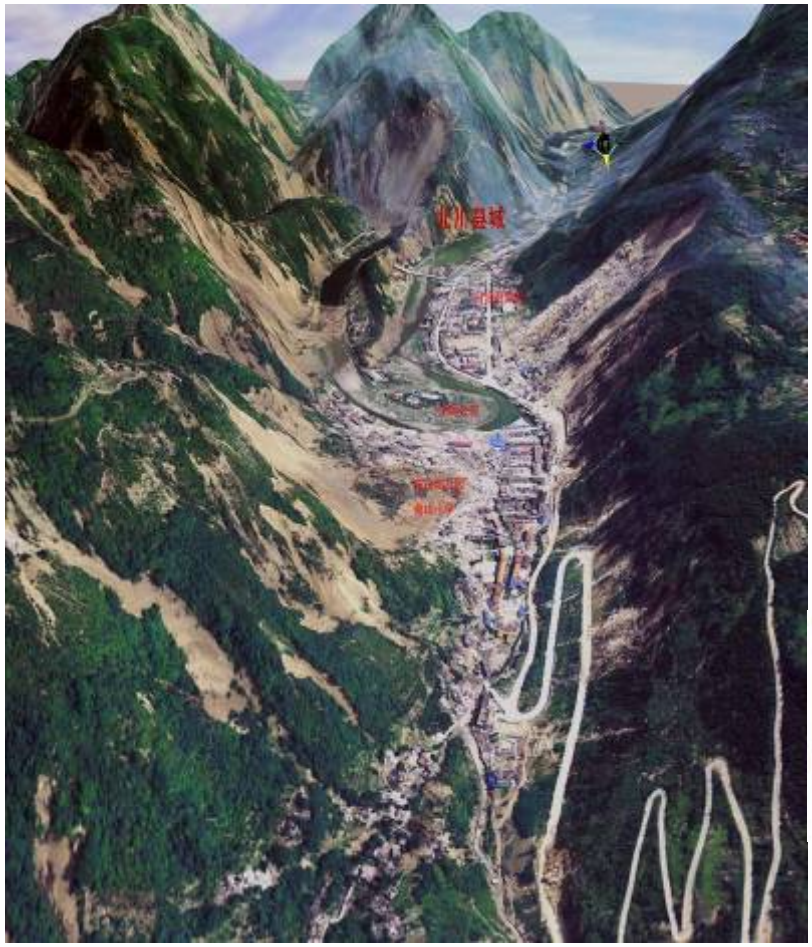
Sandstorm monitoring

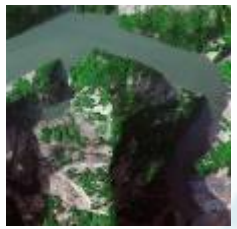
Sandstorm climate distribution map using FY satellites in 2004



Geological Disasters Monitoring

Wenchuan earthquake



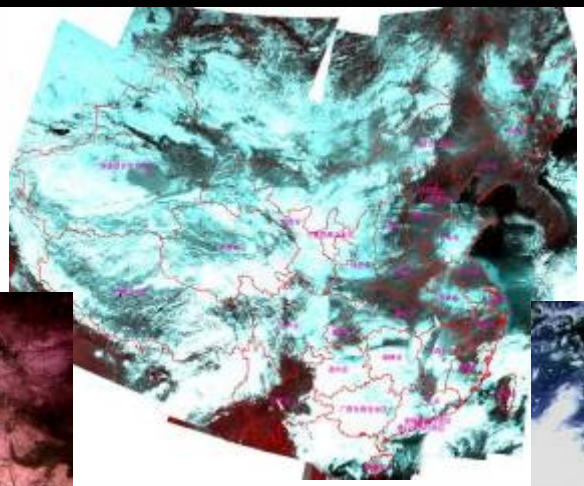


5月16日　　19日　　23日

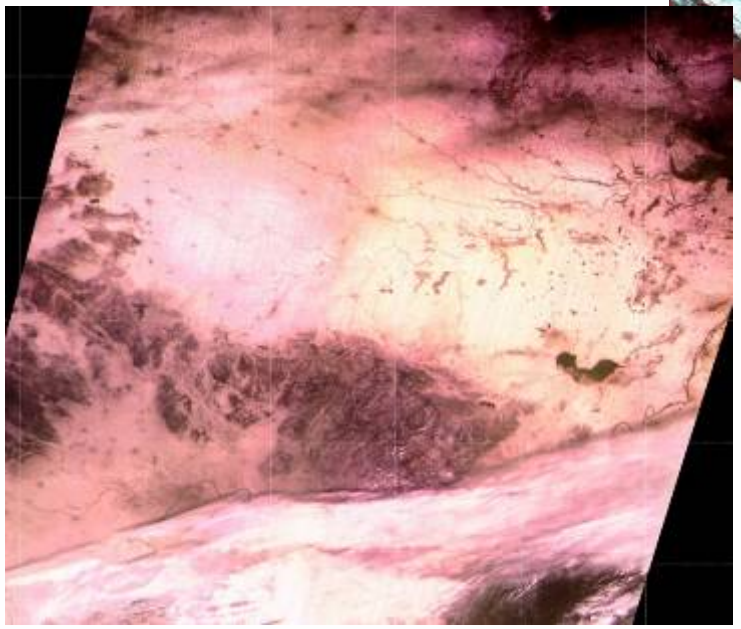
24日　　25日　　26日　　27日

Water level monitoring

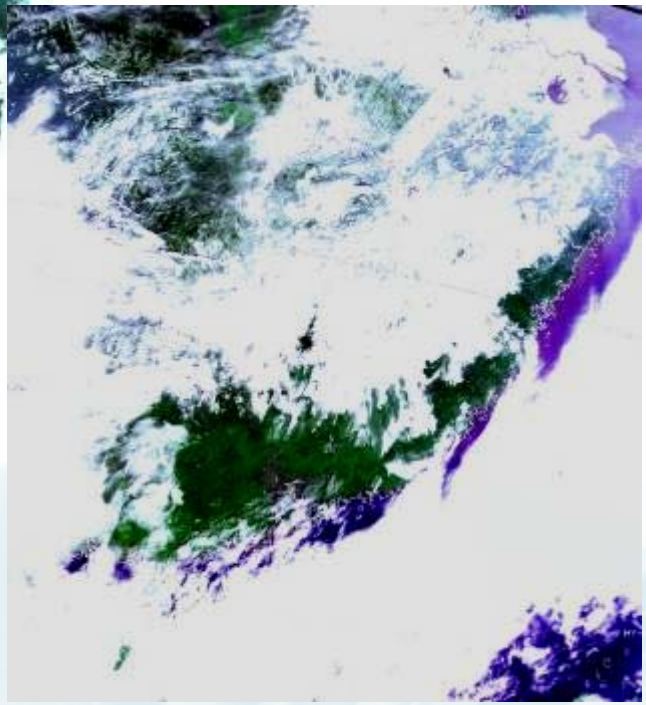
Snowstorm Monitoring



Snowstorm Monitoring using CBERS data



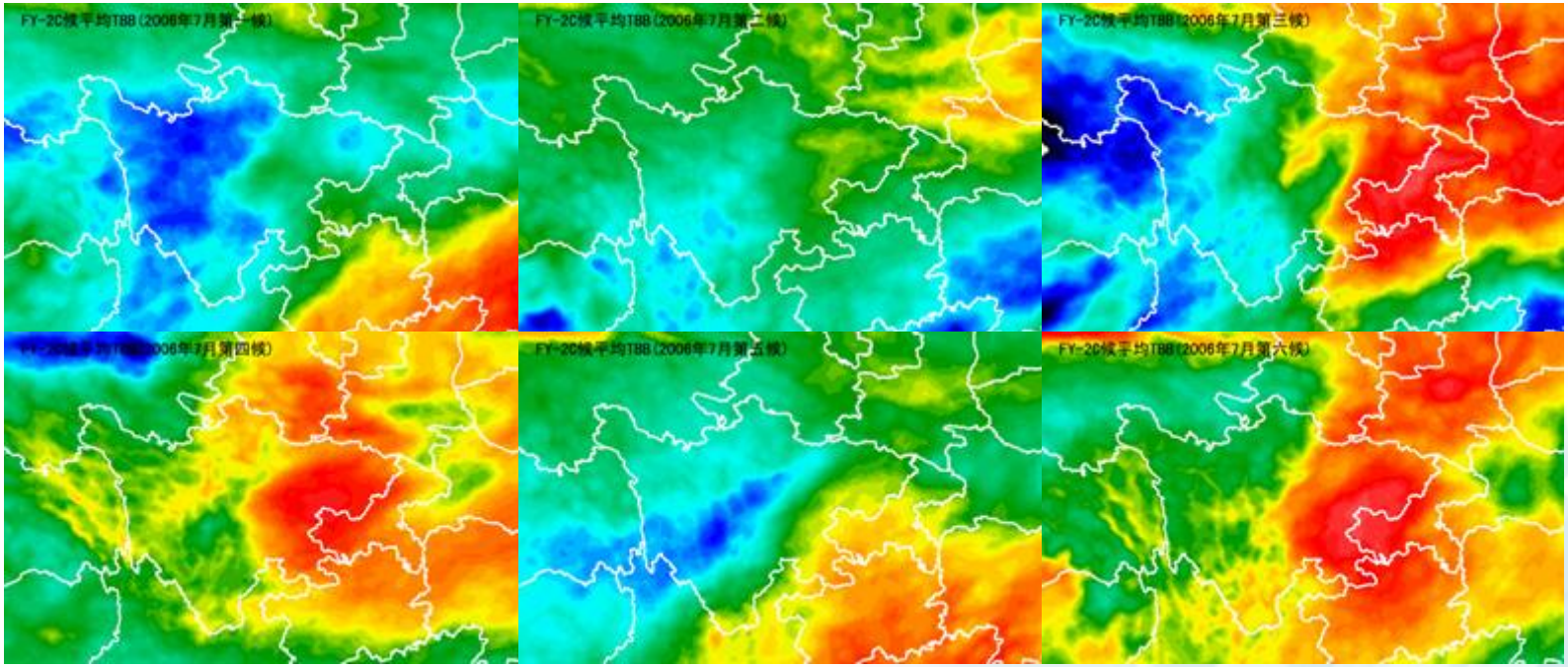
2008 January 31, HY-1B coastal zone image
Result: large-scale snow cover in Anhui & Jiangsu provinces



2008 January 31, HY-1B water color image
Result: large-scale snow cover in southern provinces

Drought Monitoring

The following figures show the TBB (Black body temperature) sequence charts observed by FY-2C from 2006.07 to 2006.08.

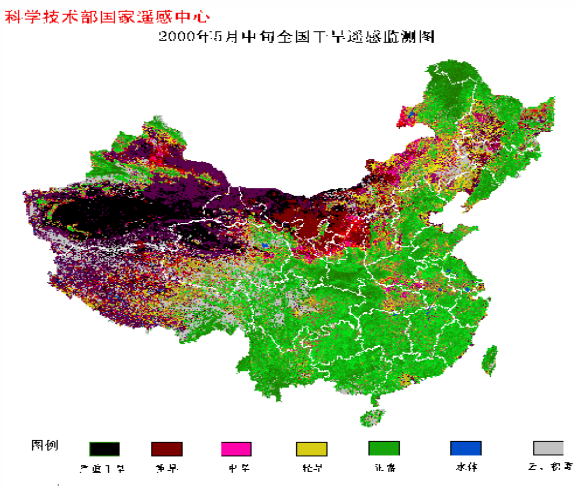


Sequence charts in 2006.07

Drought Monitoring

1999

2000



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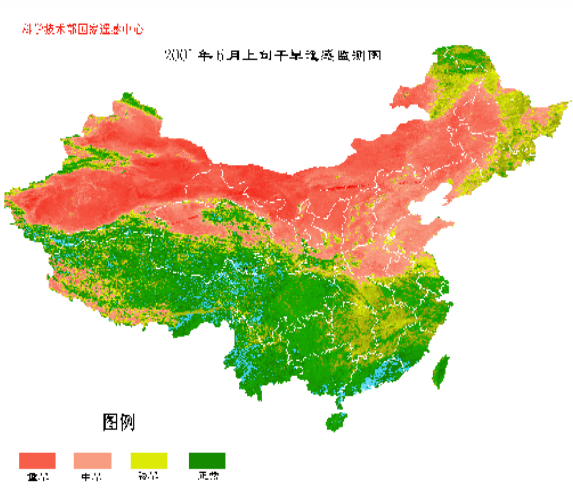

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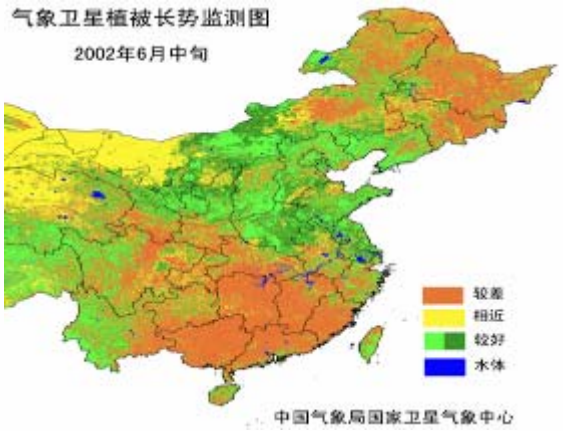

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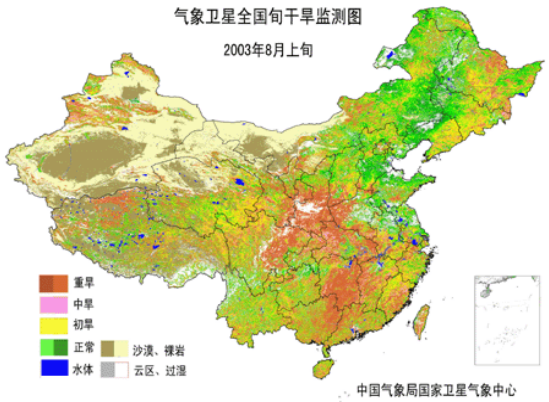

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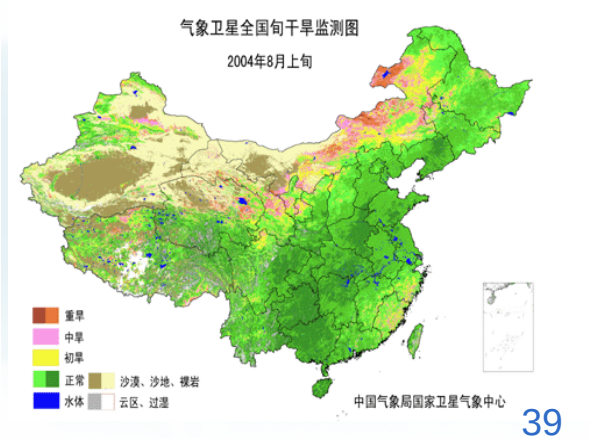
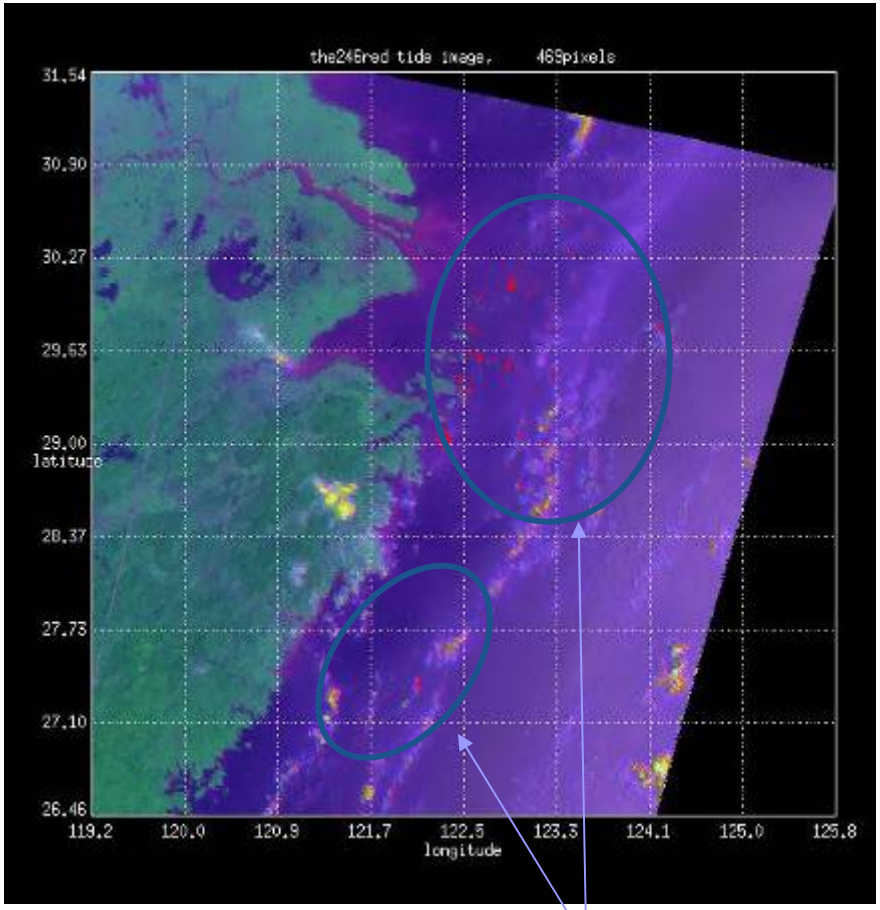
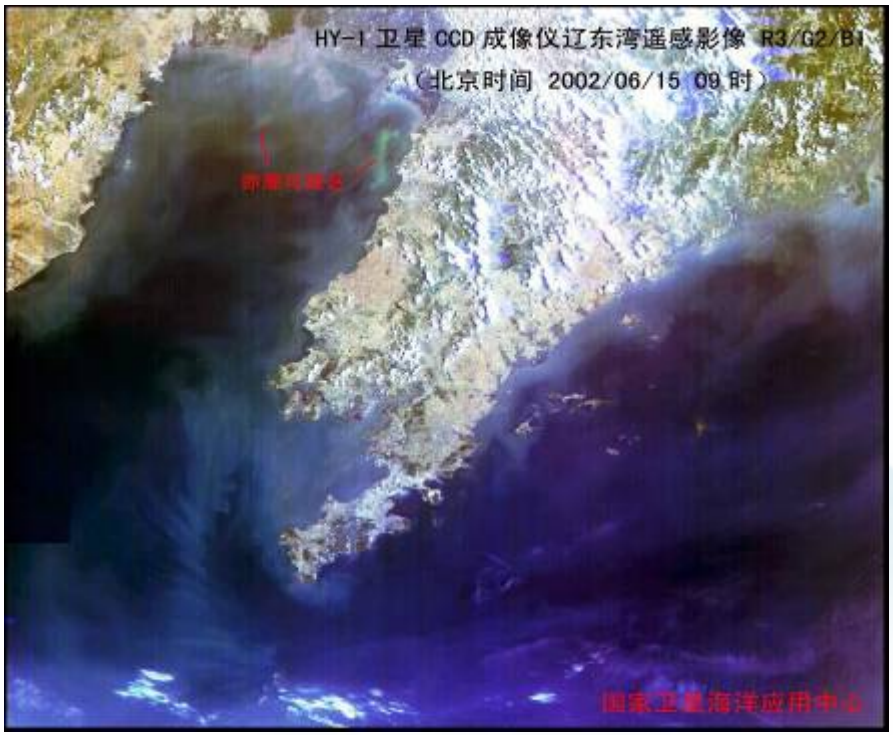


Marine monitoring



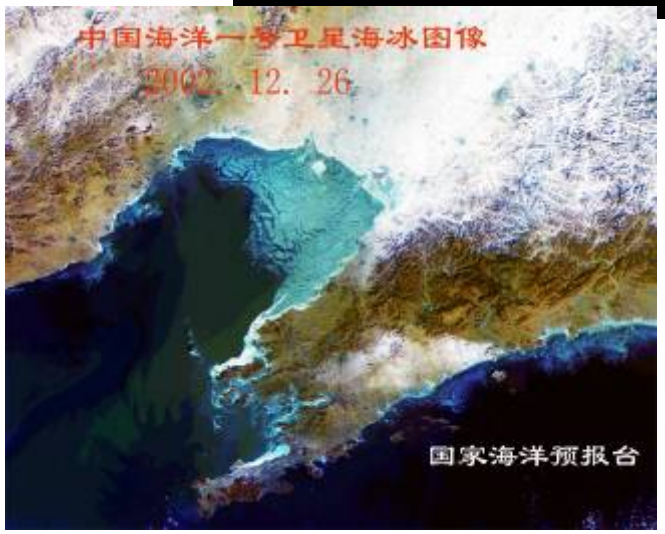
2002 September, red tide in Donghai

2002 June15 Red tide zone observed by HY-1A CCD camera in Liaodong Bay, China.



Marine monitoring

Actual Measurement



Forecasting

Thickness、concentration、edge

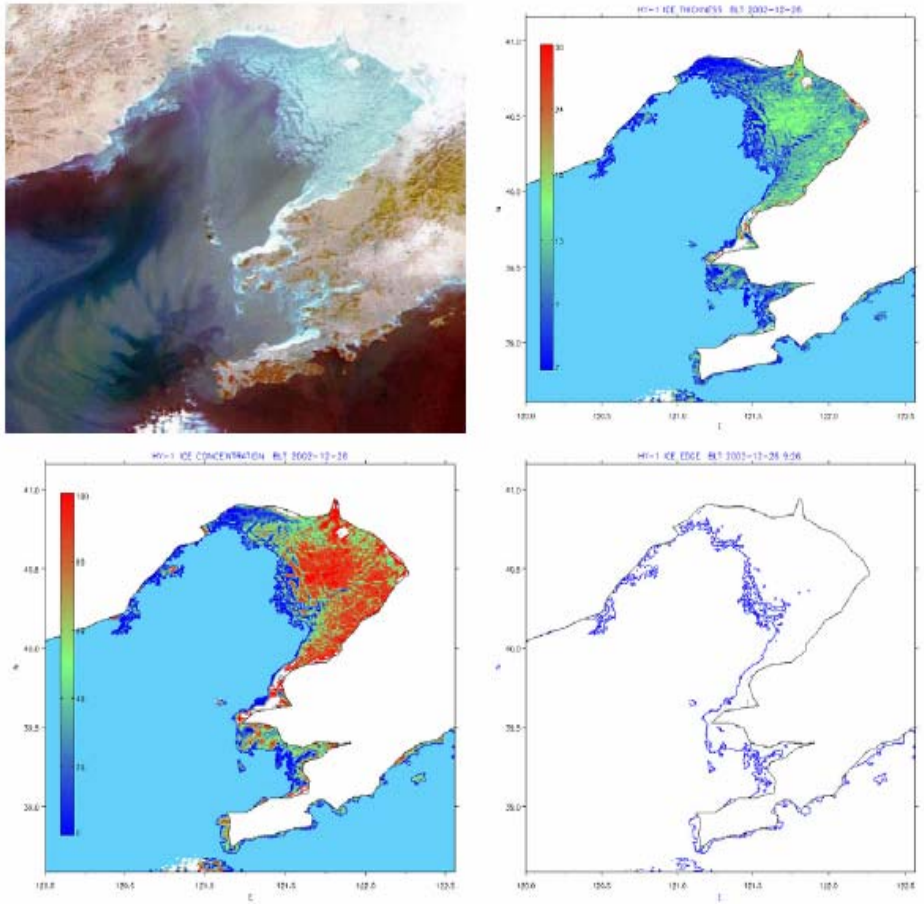
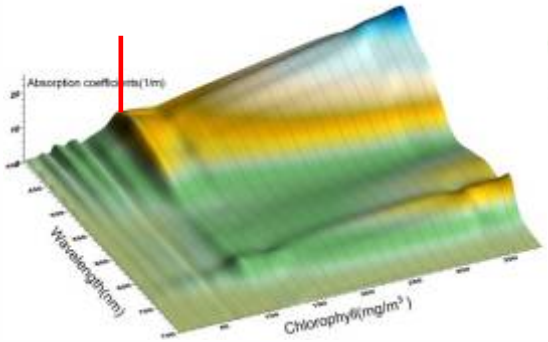
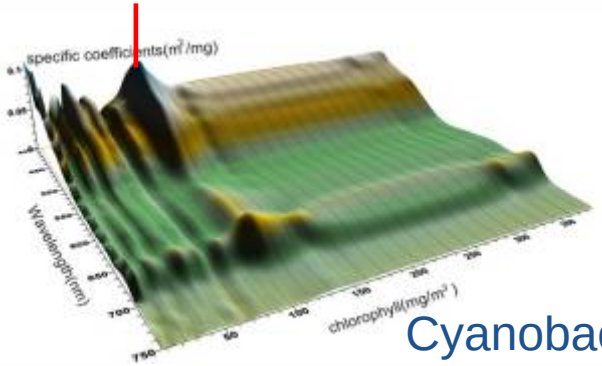


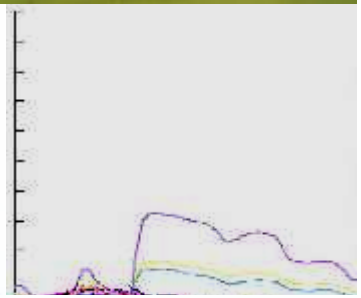
Figure 7. The sea ice image and ice thickness, concentration, edge distribution from CCD

Derived the results with high accuracy and timeliness through Improving forecasting initial field

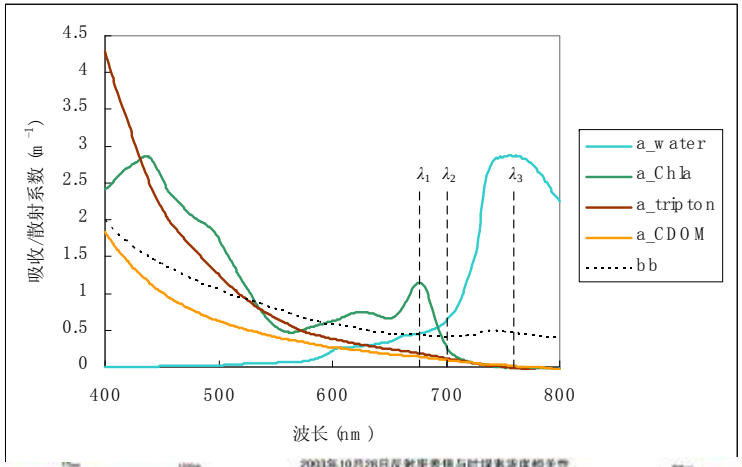
Ecological Environment Monitoring

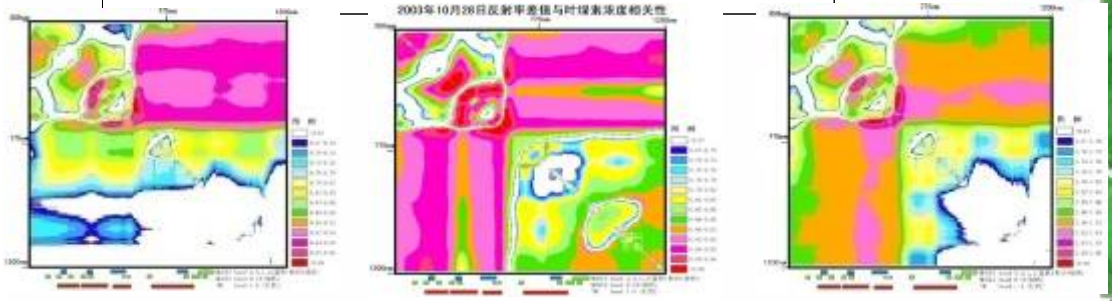


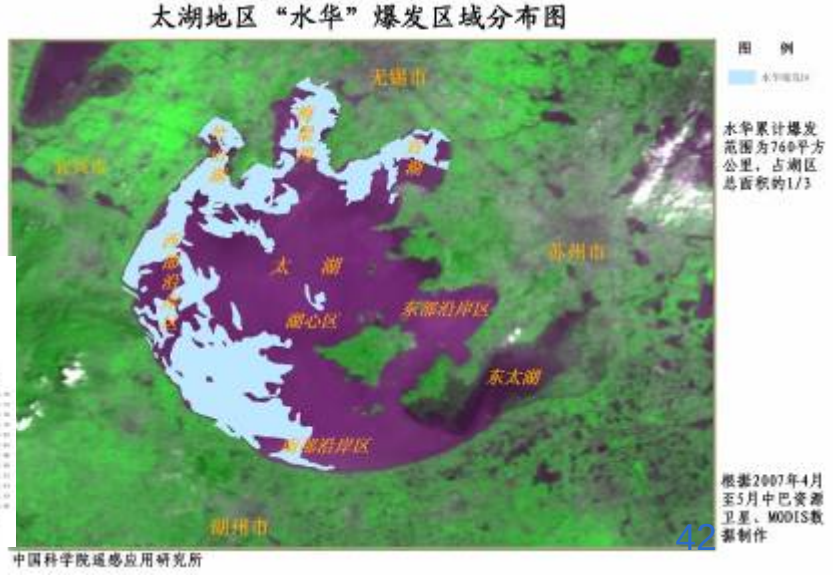




Cyanobacteria monitoring using CBERS and MODIS in Taihu lake area in 2007








Post-disaster
(reconstruction)

Damage assessment

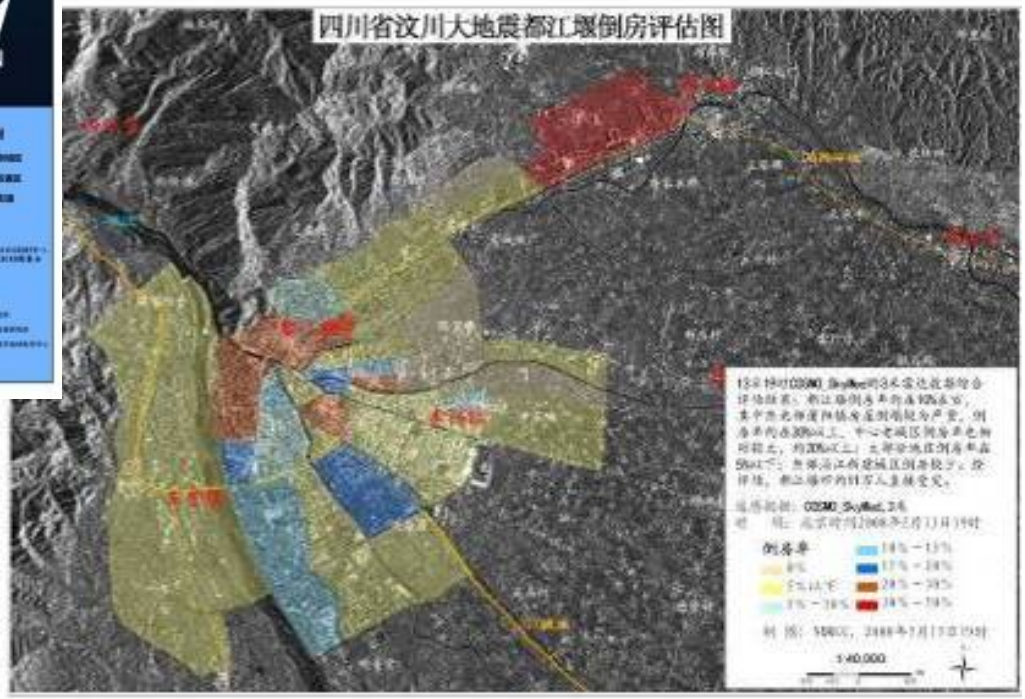
- forest fire assessment;
- house collapse assessment ;
- snow disaster assessment;
- stricken population assessment;
- ……

Reconstruction planning after the disaster

Damage Assessment

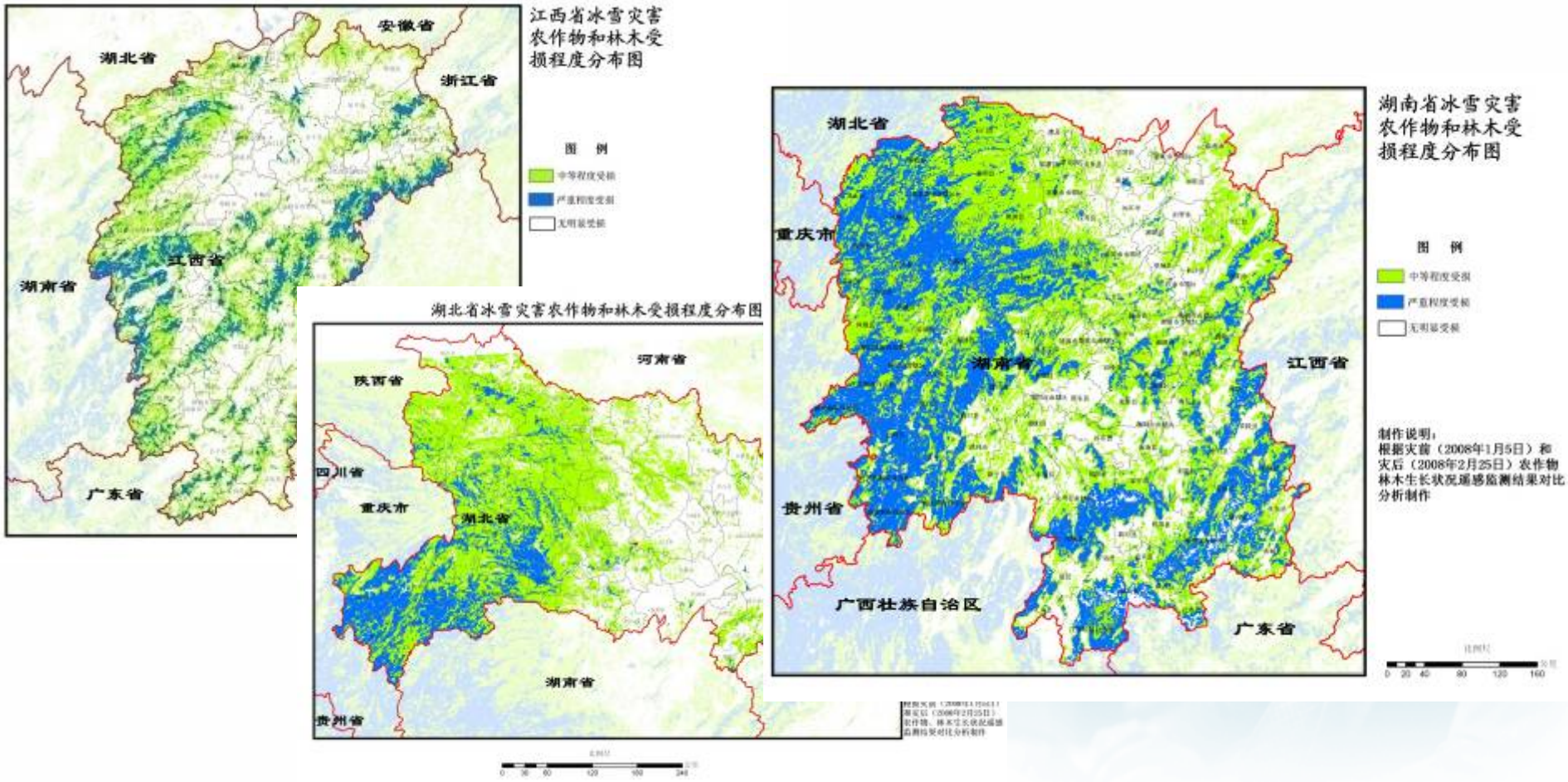
Houses damage assessment map of Haiti earthquake

Houses damage assessment map of Wenchuan earthquake



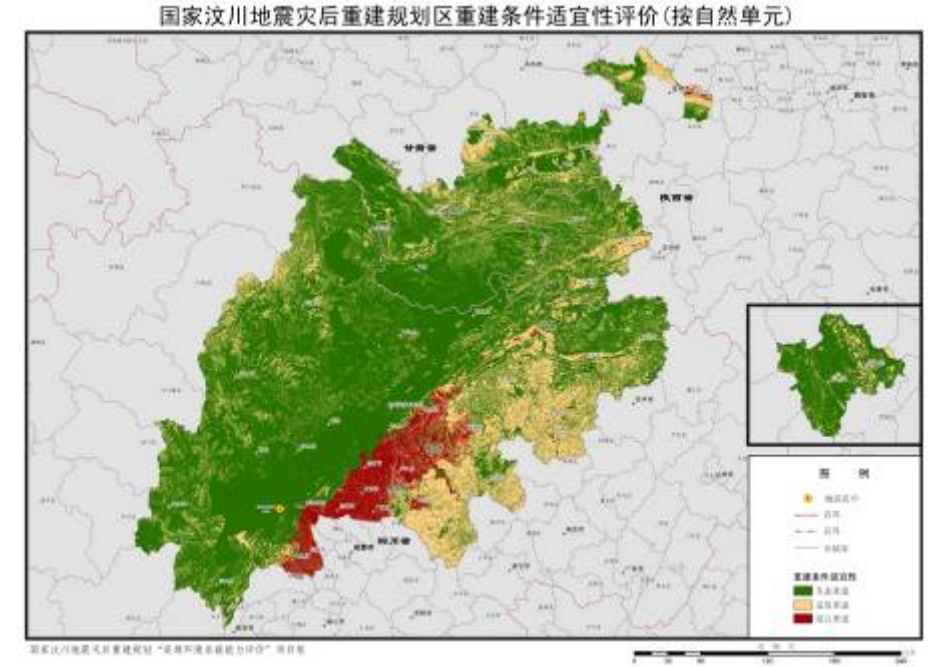
Damage Assessment

Damage assessment of southern snow disaster



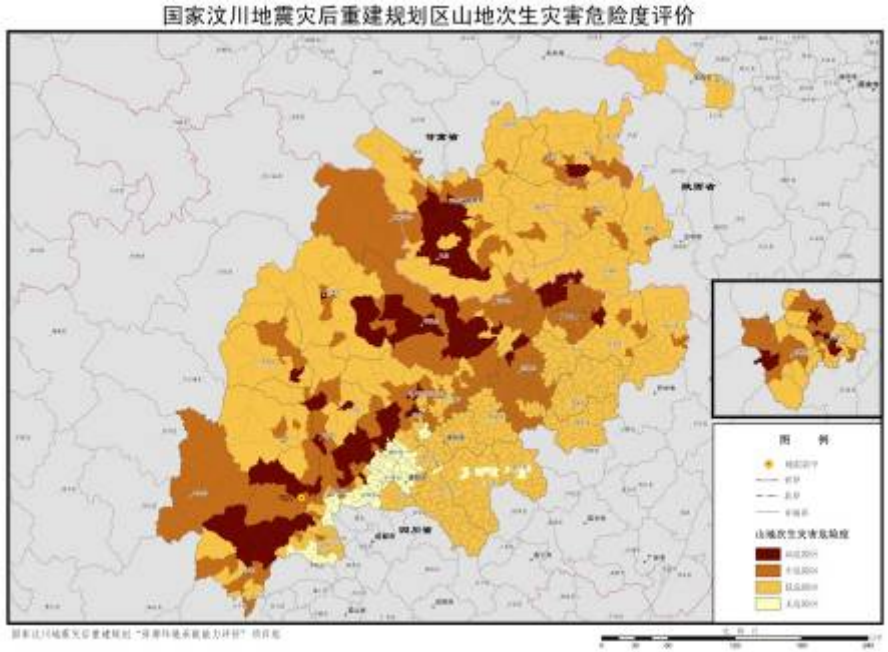

reconstruction

Reconstruction planning of Wenchuan earthquake



Suitability evaluation of reconstruction

Secondary disaster risk evaluation of mountain areas



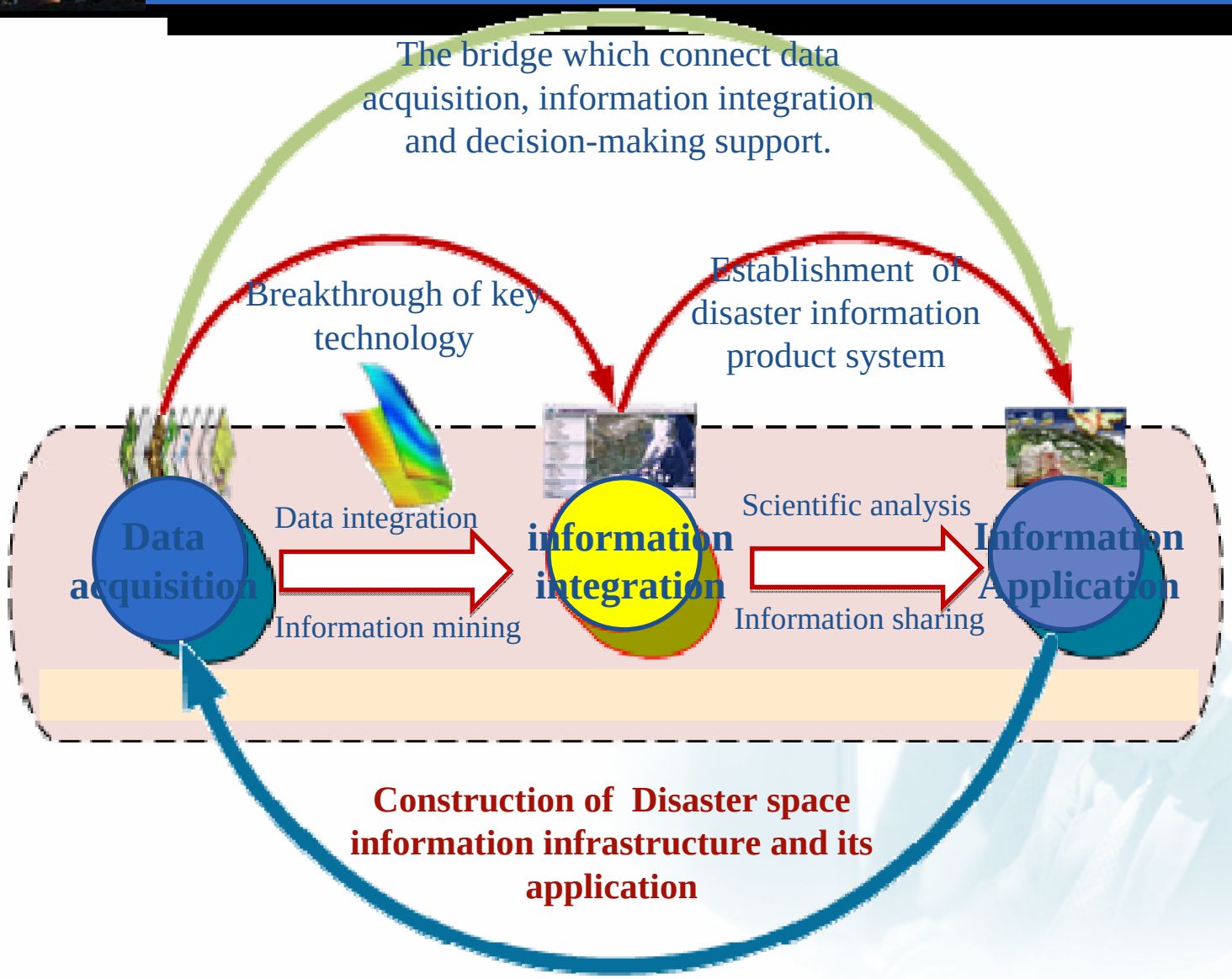

Contents

3. Future Tendency

Tendency

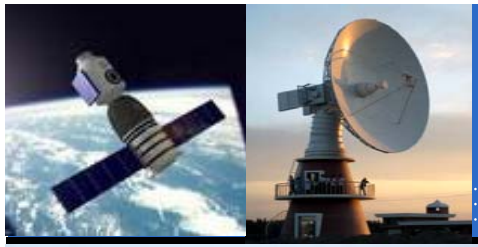
- High spatial resolution and wide coverage
  - Improvement on precision, sub-meter -> Centimeter (margin)
  - Improvement on efficiency, wide coverage
- Multi-Spectral, total band, entire angular range detecting and quantitative application of remote sensing
  - spectral resolution to nm level
  - Fully-polarized SAR, InSAR
  - new spectrums
- Combination of small satellites and regular satellites
  - platform->payload
  - agile satellite with high-performance
  - multi-pattern imagery
  - rapid reaction and flexible operation on attitude control
  - synchronous detecting of multi-payload

The end


The bridge which connect data acquisition, information integration and decision-making support.
Breakthrough of key technology
Establishment of disaster information product system
Data acquisition
Data integration
Information mining
information integration
Scientific analysis
Information sharing
Information Application
Construction of Disaster space information infrastructure and its application

The end

- China is greatly developing earth observation system, the high-resolution earth observation system is being constructed and spatial information infrastructure of national natural disasters is being demonstrated.
- The space-aviation-ground integrated earth observation system is playing more and more important role in the disaster mitigation.
- China is prepared for promoting the sharing of data and information technology to cope with natural disaster with other countries together.



THANK YOU !