

## **Introduction of the HY-1B satellite and its application**

HY-1B satellite is the successor of HY-1A satellite. It is used to detect ocean color and sea surface temperature. It was successfully launched on 11 April, 2007. The main sensors on board include the 10-band Chinese Ocean Color and Temperature Scanner (COCTS) as well as a 4-band Coastal Zone Imager (CZI)..

During in-orbit testing, the calibration and validation work has been done. And the characteristic of platform and sensors were got. The product for ocean color and SST were formed. The data quality from sensors and satellite specifies are better than HY-1A .Data from the satellite can be used in marine resource management, marine environment monitoring and protection, marine disaster monitoring and forecasting, oceanographic research and international cooperation.

# Introduction of the HY-1B satellite and its application

## 1. Introduction

The HY-1B satellite was successfully launched to altitude of 798 km in a near sun-synchronous polar orbit by a CZ-2C rocket at the Taiyuan Satellite Launching Center in north China's Shanxi Province, on 11 April 2007. Ground stations in Beijing and Sanya, on 20 April, received the first orbit images. After in-orbit testing and process, ocean-color data for primary production, coastal zone changes and environmental monitoring of the China Seas were obtained continually, and HY-1B satellite and ground station runs operational and it was delivered to user (SOA) on Sept. 30, 2007. The thematic data products were provided by NSOAS.

## 2. HY-1B satellite characteristics and ground system

### 2. 1 satellite characteristics

The main use of HY-1B is to detect the marine environmental parameters of the China Seas, including chlorophyll concentration, suspended sediment concentration, and dissolved organic matter, pollutants, as well as sea surface temperature. The satellite will play an important role in developing and utilizing the marine bio-resources, constructing and managing the harbor, detecting the ocean pollution, investigating and developing coastal resources and studying the global environmental changes.

HY-1B satellite is a small satellite with a mass of approx.443kg and a power generation capability of more than 500W, three-axis stabilized. The working life is about 3 years. The spacecraft was launched by CZ-2C rocket and operate in a near sun-synchronous and near-polar orbit at altitude of 798 km. The satellite is composed of the communication and data transmission subsystem, the electrical power subsystem and the attitude and orbital control subsystem. On the satellite there are two sensors, one is the COCTS, the other is CZI. Their main characteristics are listed in table 1:

Table 1: Satellite and Orbit Characteristics

Orbit type	Near Circular and near sun-synchronous
Equator crossing time	10:30am (descending node)
Altitude	798km
Inclination	98.6 deg
Period	100.8 minute
Repeat observation period	1 days for COCTS, 7 days for CZI
Mass	443kg
Payload	COCTS and CZI
Attitude control	3 axis stabilized
Downlink frequency	X-band
Design life	3 years
Memory recorder on board	250Mbyte ( can record 34 minute COCTS data)

The COCTS is an optical radiometer to detect ocean color and surface temperature. COCTS has a function to detect the amount of chlorophyll and dissolved substances in the water, and temperature distribution. The data of COCTS will be used to get the information of ocean conditions for fishery and environment monitoring. Its

repeat period is 1 day. There are 8-channel visible and near-infrared band and 2-channel thermal infrared band with the spatial resolution of 1.1km.

The CZI is a medium spatial resolution optical sensor for observing ocean color, land and coastal zones. CZI has 4 spectral bands from 0.433-0.695 $\mu$ m with spatial resolution of 250m. The CZI data will be used for regional mapping of different water constituents and vegetation, monitoring pollution of coastal zones for resource exploration etc. Its repeat period is 7 days. The main characteristics are summarized in table 2. 3. 4

Table 2 Major parameters of COCTS and CZI

Parameter	COCTS	CZI
Spatial resolution	1.1km	0.25km
Scan coverage	3803km	500km
Digitization	10bit/pixel	12bit/pixel
Radiometer accuracy	10%	10%

Table 3 COCTS bands and detecting object

Band (micro m)	Main detecting object
0.402-0.422	Yellow substance 、 water pollution
0.433-0.453	Chlorophyll absorption
0.480-0.500	Chlorophyll 、 sea ice 、 pollutant
0.510-0.530	Chlorophyll 、 water depth 、 pollutant 、 suspended sediment
0.555-0.575	Chlorophyll 、 vegetation 、 sand
0.660-0.680	Fluorescence 、 suspended sediment 、 atmospheric correction 、 aerosol
0.740-0.760	Suspended sediment 、 atmospheric correction 、 vegetation
0.845-0.885	Atmospheric correction 、 water vapor
10.30-11.40	Surface temperature
11.40-12.50	Surface temperature

Table 4 CZI bands and detecting object

Band (micro m)	Main detecting object
0.433-0.452	Ocean color 、 pollutant 、 sea ice
0.555-0.575	Suspended sediment 、 pollutant 、 sea ice 、 shoal
0.655-0.675	Suspended sediment 、 fluorescence 、 soil 、 vegetation 、 red tide 、 atmospheric correction
0.675-0.695	Vegetation 、 fluorescence 、 soil 、 red tide

## 2.2 The ground system

The HY-1B satellite ground system consists of components for data receiving and preprocessing, data processing, data archiving and distribution, calibration and validation, communication, operation control and application and demonstration subsystem. The ground segment is very important to demonstrate satellite application. NSOAS is responsible for marking the satellite observation schedule, real-time receiving and processing archiving and distribution of HY-1B satellite information products for marine environmental parameters forecast operational. The structure of HY-1 ground system shows as Fig.1. In order to get more data, Mudanjiang Station is considering and it will be set up in the next year.

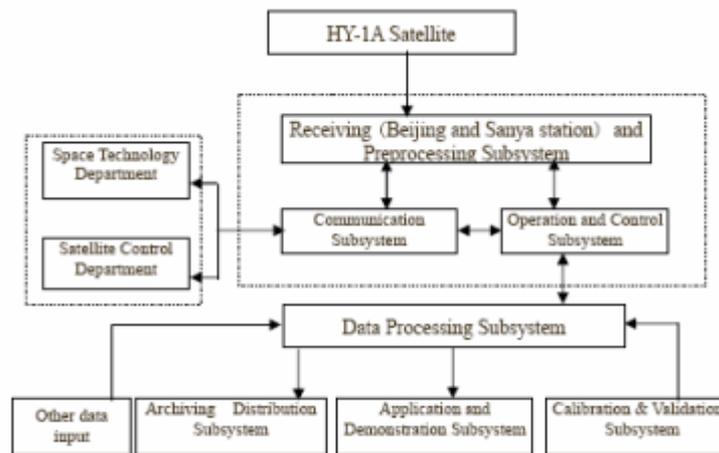


Fig. 1. The Structure of HY-1 ground system

There are four Level data product types after processed for HY-1satellite as table 5, and the data format is standard HDF.

Table 5 HY-1 satellite data product types

Level	Sensor	Data product type
Level-0	COCTS	COCTS raw data after unpacked (L0)
	CCD	CCD raw data after unpacked (L0)
Level-1	COCTS	After geographic location (L1A), and radiance calibration (L1B)
	CCD	After geographic location (L1A), and radiance calibration (L1B)
Level-2	COCTS	6 Normalized water-leaving radiance (412、443、490、510、555 and 670 nm) 3 aerosol radiance (670、750 &865nm) Chlorophyll-a concentration SST Pigment concentration Aerosol optical thickness at 865 nm Suspended matter concentration Diffuse attenuation coefficient
	CZI	Suspended sediment
Level-3	COCTS	Monthly and week statistical report for level-2
	CZI	Thematic data product

### 3. Applications and product show

Since April 2007 HY-1B satellite has monitored large sea areas of China, the Pacific, Indian, Atlantic and Arctic oceans, as well as the North poles. Two ground stations have got 2 or 3 passes each day. The coverage of the Beijing and Sanya ground stations as Fig. 2. These remote sensing imageries cover different sea areas and inland surface present so abundant coastal features, morphology and marine information, bright and gorgeous rivers, lakes and seas as well as various land vegetations. The quantitative satellite remote sensing products including chlorophyll, suspended sand, and sea surface temperature were developed. Application service projects such as

studies of ocean fisheries, marine primary productivity, monitoring of red tide, sea surface temperature, and sea ice and coastline variation will be fulfilled.

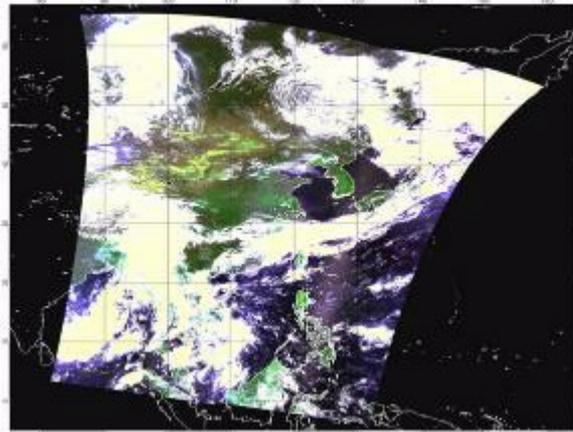


Fig.2 HY-1B one day mosaic image of the Beijing and Sanya ground station (R/ch6, G/ch7, B/ch3)

#### (1) Monitoring of ocean color

Ocean color is one of the basic elements of the marine environment and an important index of reference for activities such as offshore production and oceanographic research. Large scale and periodical acquisition of ocean color information was realized in the offshore and the adjacent sea areas by using HY-1B Satellite. Meanwhile we have got Chlorophyll-a average distribution and month change from COCTS level-2 product. Fig. 3 shows Chlorophyll-a average distribution in China's sea area. Fig.4 shows suspended sediment average distribution in China's sea area.

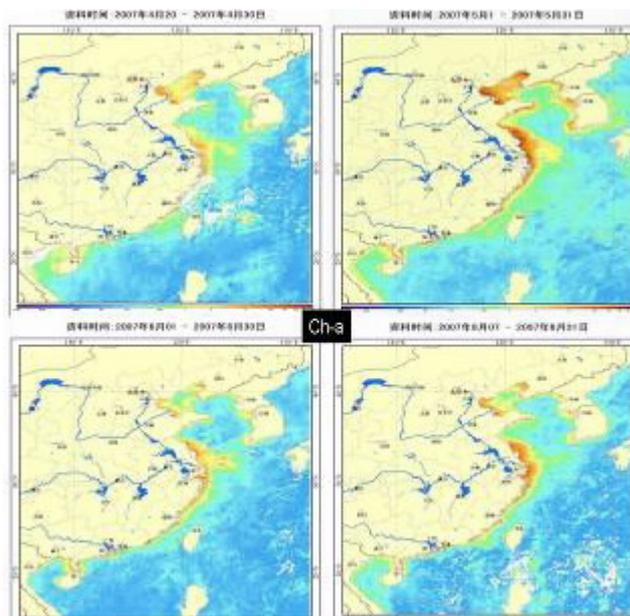


Fig.3 Chlorophyll-a average distribution in China's sea area in April, May, June and August 2007

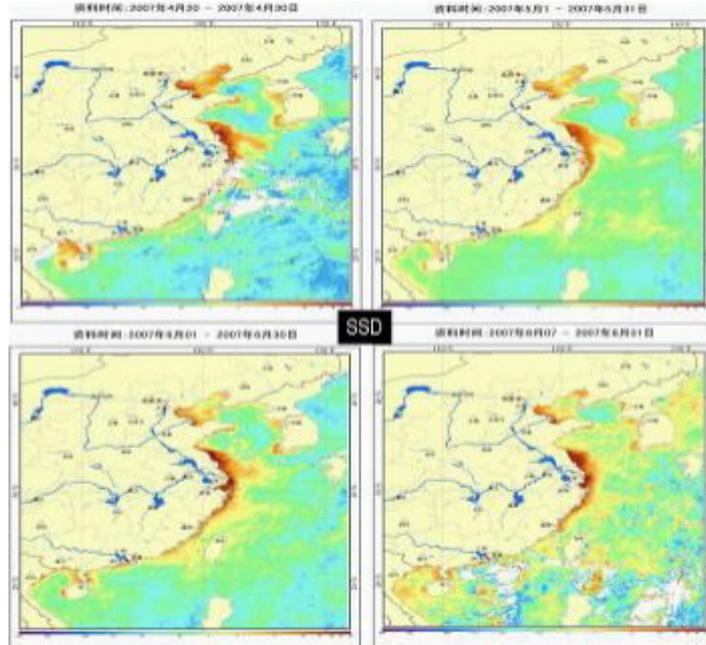


Fig.4 Suspended sediment average distribution in China's sea are in April, May, June and August 2007

(2) Monitoring of sea surface temperature

Sea surface temperature (SST) is also an important variable about the dynamics of the marine environment. We can get SST from channel 9 and Channel 10 of COCTS on HY-1B Satellite, and we can also get the SST distribution and 4 months change. Fig. 5 shows SST average distribution in China's sea area.

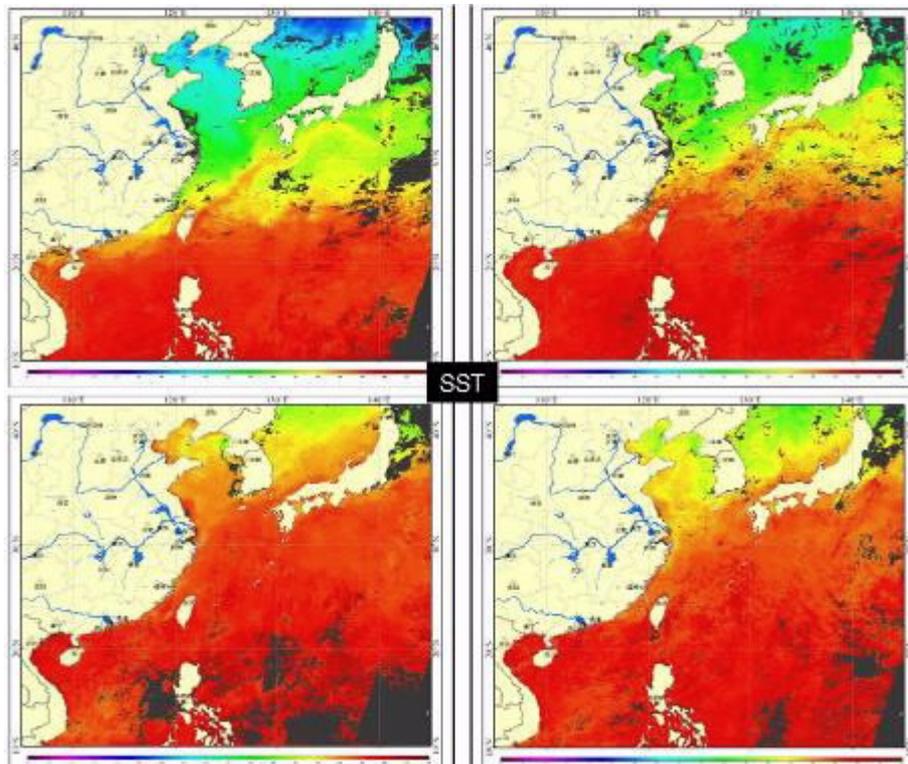


Fig.5 Sea surface temperature average distribution in China's sea are in May, June July and August 2007

### (3) Sea ice monitoring

The arctic sea ice and icecap image from CZI was got in our in-orbit testing period. The size and concentration can be estimated.

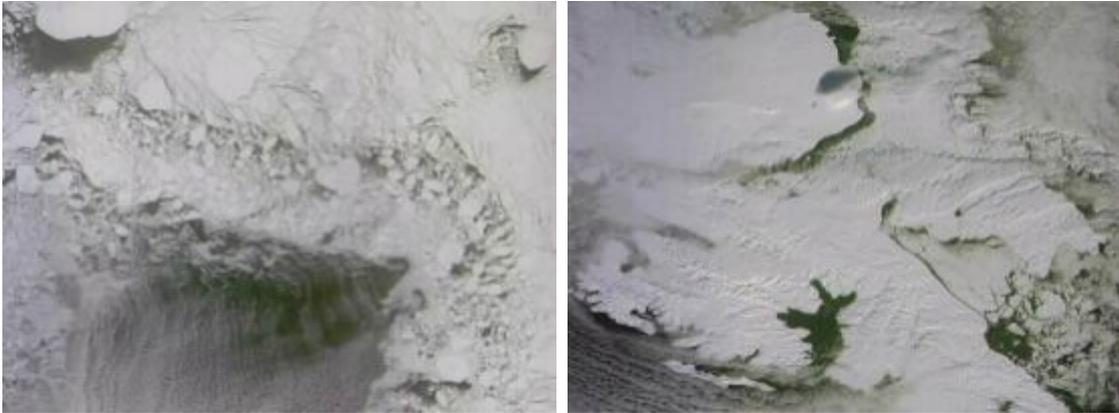
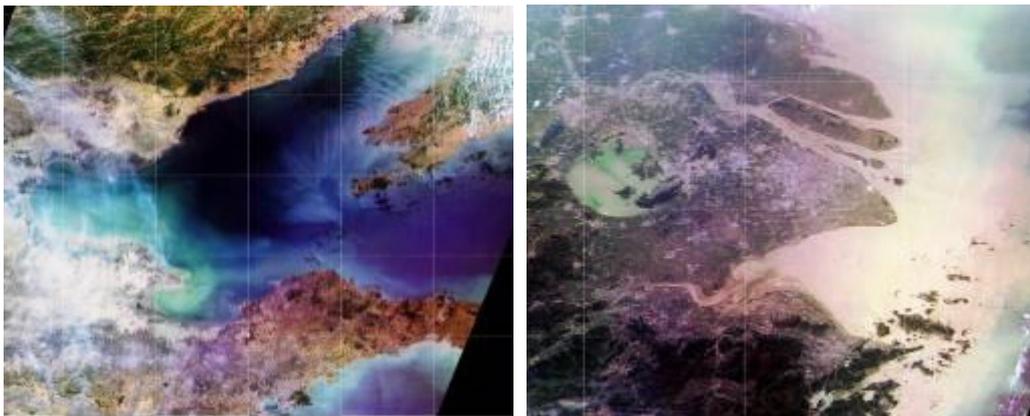


Fig.6 Sea ice distribution in Arctic area on 27 and 28 April 2007

### (4)Monitoring coastal zone

Many images of the environment in the Yellow River estuary, the Yangtze River estuary and the Qiongzhou strait were formed, using the high resolution remote sensing data provided by the CZI imager on HY-1B Satellite. All of the charts are highly useful in the resource investigation in the coastal areas, the monitoring of the dynamic variation of the coastline, the research on the distribution characteristics of suspended sediments in the estuaries, and the study on the classification and utilization of lands in the estuaries. They played important role in the functional zoning of the coastal areas, in the coastal zone management and in the utilization of resources in the estuaries in China. Fig.7 shows sediment distribution of the Bohai sea, the Yangtze River estuary and the Qiongzhou strait from HY-1B CZI.



Bohai Sea from CZI

the Yangtze River estuary from CZI



The Qiongzhou strait and Hainan island from CZI

Florida Strait from COCTS

Fig.7 coastal zone image from HY-1B

#### 4 The status of the on-orbit HY-1B

The HY-1B satellite detects earth and data downlink works simultaneity when it passes the receiving area of Beijing and Sanya ground stations. Two or three orbit passes were received on day time. For outside receiving area, the detecting data was deposited on the board memory and transmitted at night. The data of two sensors can be recorded when they detect outside China Seas. The first orbit images were received and processed by ground stations in Beijing and Sanya, on 20 April 2007. After in-orbit testing and process, ocean-color data for primary production, coastal zone changes and environmental monitoring of the China Seas were obtained continually, and HY-1B satellite and ground station runs operational and it was delivered to user (SOA) on Sept. 30, 2007. And it made observations on 755 orbit tracks over earth include 346 orbit tracks outside China seas. Fig.8. shows schematic diagram of observing area.

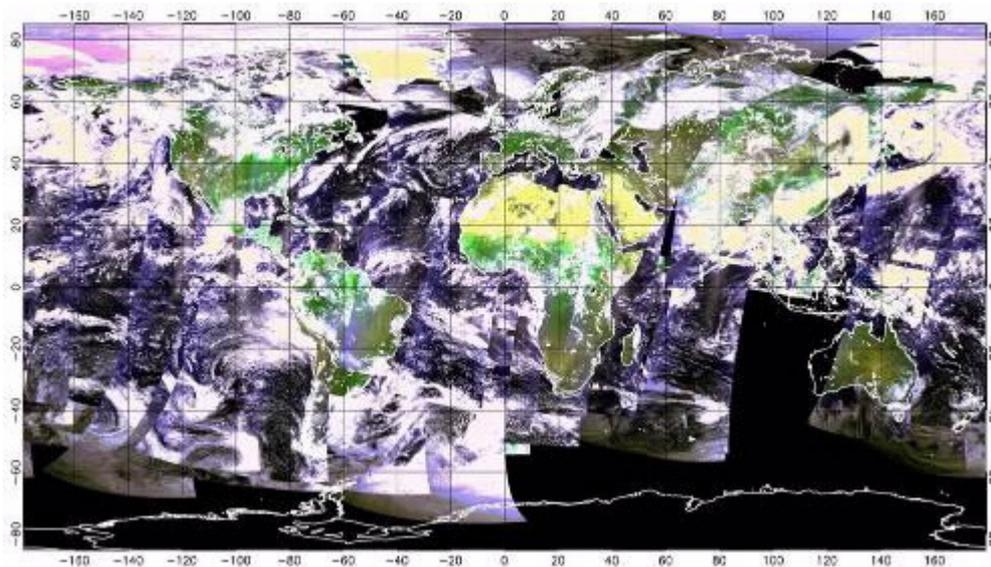


Fig 8.HY-1B satellite observed area from April 20 to Sept.30

#### 5.. Conclusion

HY-1B satellite is an operational satellite for ocean color remote sensing in China, it will run three years and will be used widely for marine environmental monitoring. We will continue to develop Chinese own ocean satellite and utilize other satellites as much as possible; we will also promote international cooperation in remote sensing for globe environment problem.