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Prepared by CNSA
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Discusses in Plenary

Status of the HY-1B satellite and its application

The Chinese Ocean Color Series Ocean satellite (HY-1) is an operational satellite for detecting ocean color and sea surface temperature. The first satellite was successfully launched on 15 May, 2002; the second was launched on 11 April 2007 and still run onboard now. The payloads on satellite include a 10-band Chinese Ocean Color and Temperature Scanner (COCTS) and a 4-band CCD imager.

HY-1 satellite and its application in China

1. Introduction

The HY-1A satellite was successfully launched on 15 May 2002 and 11 April 2007 for HY-1B satellite. After in-orbit operation and process, we obtain ocean-color data for primary production, coastal zone changes and environmental monitoring of the China Sea. More details as follows.

2. HY-1 satellite characteristics

The main use of HY-1 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-1 satellite main characteristics are listed in table 1:

Table 1: Satellite and Orbit Characteristics

Orbit type	Near Circular and near sun-synchronous
Equator crossing time	8:53-10:10am (descending node)
Altitude	798km
Inclination	98.8 deg
Period	100.8 minute
Repeat observation period	3days for COCTS, 7days for CCD
Mass	367kg
Payload	COCTS and CCD
Attitude control	3 axis stabilized
Downlink frequency	X-band
Design life	2 years
Memory recorder on board	80Mbyte (can record 18 minute COCTS data)

There are two sensors on the HY-1 satellite, 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 3 days. There are 8-channel visible and near-infrared band and 2-channel thermal infrared band with the spatial resolution of 1.1km. The CCD is a medium spatial resolution optical sensor for observing ocean color, land and coastal zones. CCD has 4 spectral bands from 0.42-0.89μm with spatial resolution of 250m. The CCD 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 and 4.

Table 2. Major parameters of COCTS and CCD

Parameter	COCTS	CCD
Spatial resolution	1.1km	0.25km
Scan coverage	1400km	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
0.730-0.770	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. CCD bands and detecting object

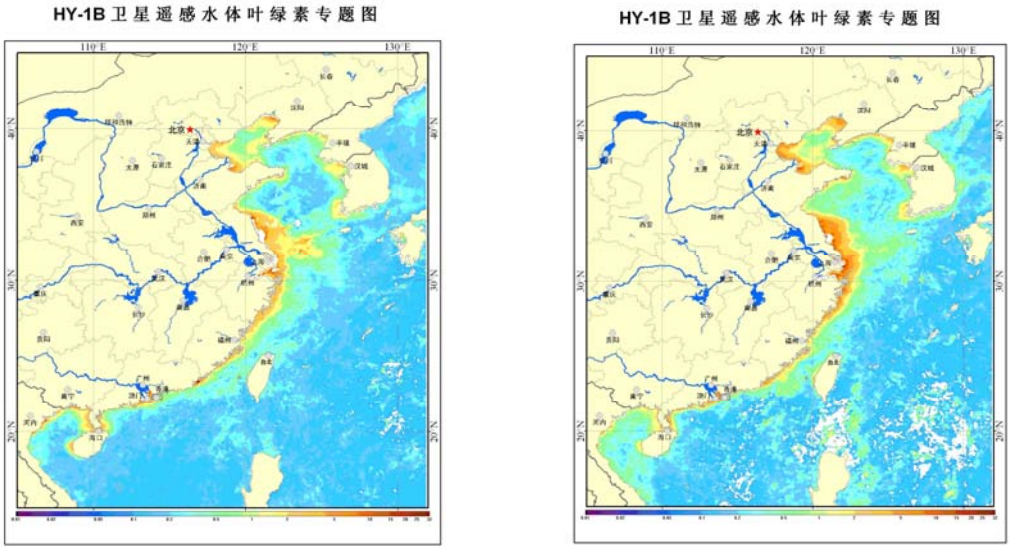
Band (micro m)	Main detecting object
0.42-0.50	Suspended sediment、pollutant、vegetation、sea ice
0.52-0.60	Pollutant、vegetation、ocean color 、sea ice
0.61-0.69	Soil、Atmospheric correction、water vapor
0.76-0.89	Soil、Atmospheric correction、water vapor

3. HY-1 satellite applications

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 and South poles. Two ground stations have got about 1084 orbit passes (3 passes each day). 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. After the delivery of HY-1B, the National Satellite Ocean Application Service carried out a great number of application work according to the properties of the two sensors on the satellite. Among them, distributed data processing system was studied; more than 40 quantitative satellite remote sensing products including chlorophyll, suspended sand, sea surface temperature, vegetation index 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 were fulfilled.

(1) Ocean Color parameter

We have got Chlorophyll-an average distribution and four seasons change from COCTS level-2 product. Figure 1 shows Chlorophyll-an month average distribution in China's sea area. The Figure 2 is global sea area Chlorophyll-an average distribution in 2007 from HY-1B.



June 2007 Aug. 2007

Figure1. Chlorophyll-a month average distributions in China's sea area

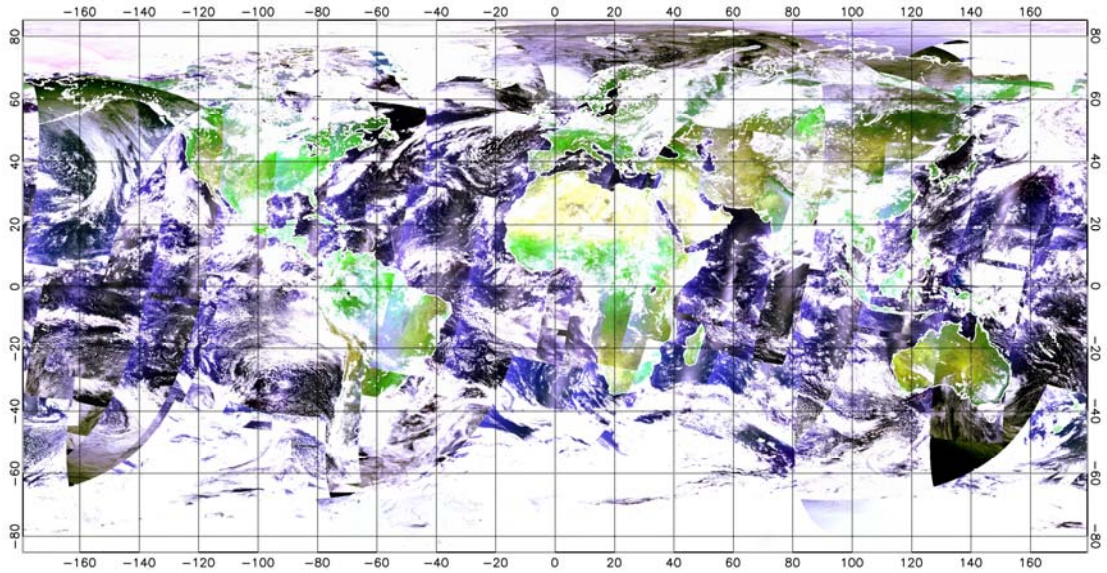
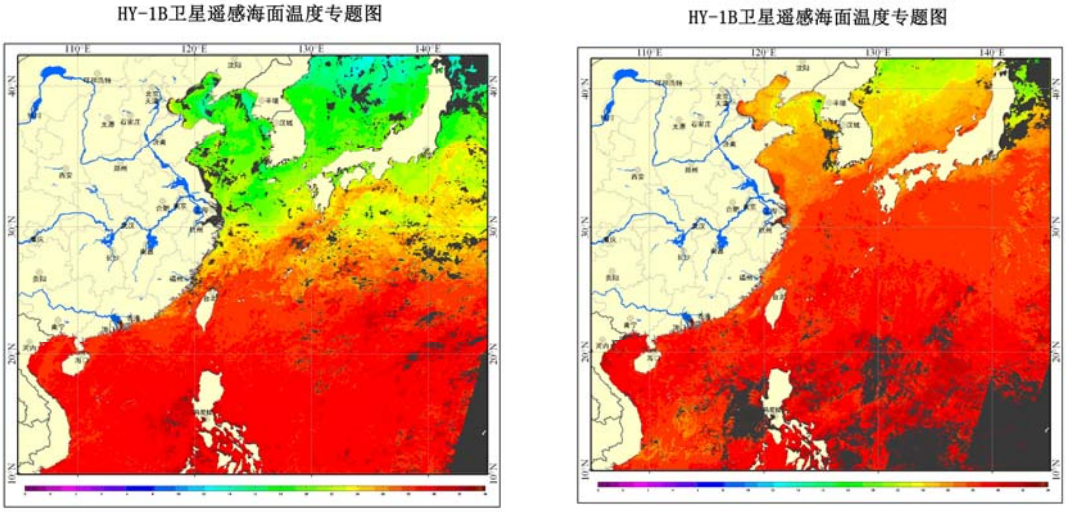


Figure2. Chlorophyll-a average distribution in Global sea area in 2007

(2) SST

We can get SST from COCTS channel 9 and Channel 10, and we can also get the SST distribution and change.



June 2007 Aug. 2007

Figure 2. SST month average distributions in China's sea area

(3) Sea Ice

The Bohai Sea covered with ice from December to March every year. The maximum extent of sea ice generally occurs in January and the typical thickness is less than 50cm. Sea ice threatens oil platform operation and the ship transportation. A variety of sea ice parameters, such as ice extent, thickness, concentration and image was extracted from visible and infrared channel of COCTS and CZI. During the winter of 2007~2008, the data of the HY-1B were applied to the sea ice monitoring and forecasting for the Bohai Sea of China for the first time.

The CH 5, 6 of COCTS are chosen for detecting cloud after experiment, and we get there are inflection points at about 25% albedo of COCTS CH 5 and at about 27% albedo of COCTS CH 6. These two points can be used as the threshold values to distinguish ice and cloud for COCTS, Similar to COCTS, the CCD CH 1 and 3 are both used for detecting cloud. If its albedo of COCTS CH 5 is greater than 14.0%, it is identified as ice. If its albedo of CCD CH 2 is greater than 12.6% or that of CCD CH 4 is greater than 5.8%, it is identified as ice. The method of piecewise linearity is used to calculate ice thickness. Albedo values corresponding to several certain ice thickness values are obtained from experiments. Then the piecewise linear interpolation is used to generate the relationship between all the values of albedo and ice thickness, the result as below:

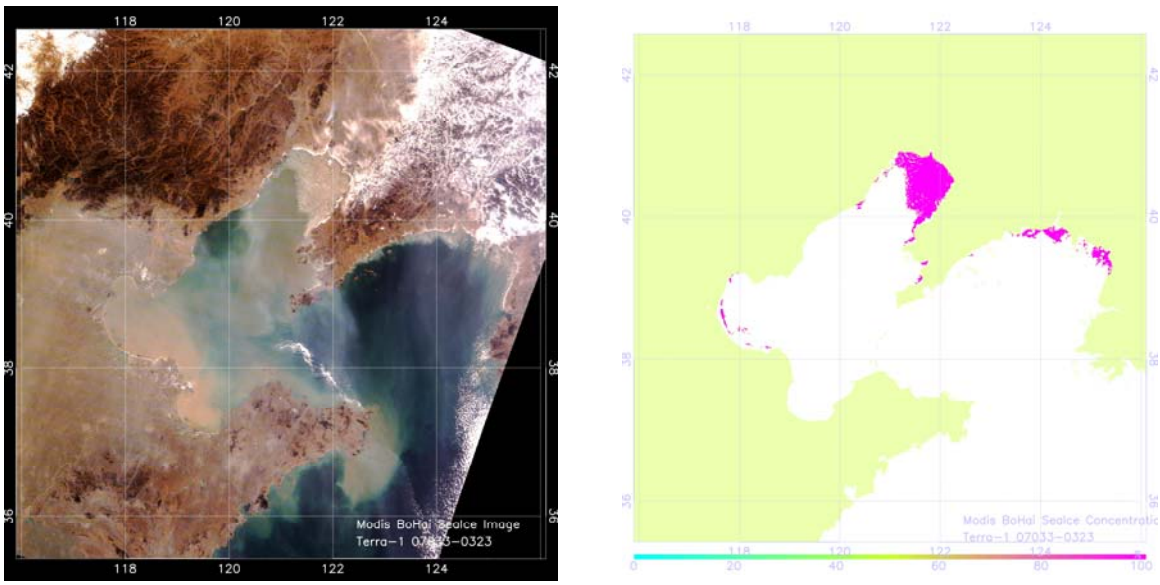
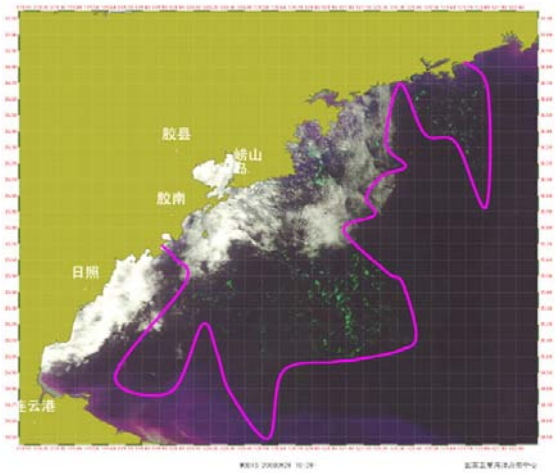


Figure 3. The sea ice image and ice thickness, concentration, edge distribution from CCD

(4) Alge Bloom Along the Coast of China

On June to July, 2008, the HY-1B satellite captured many images of Qingdao and the bay of Jiaozhou Wan. The top image is a digital camera photograph BOUT THE alge bloom. The middle image is a false-color image made from a combination of visible and infrared light from HY-1B satellite. In this image, vegetation appears vibrant green, including the strips of algae floating in the bay and in the nearby coastal waters. The underside is the thematic map about the Alge Bloom retrieved from HY-1B satellite image.



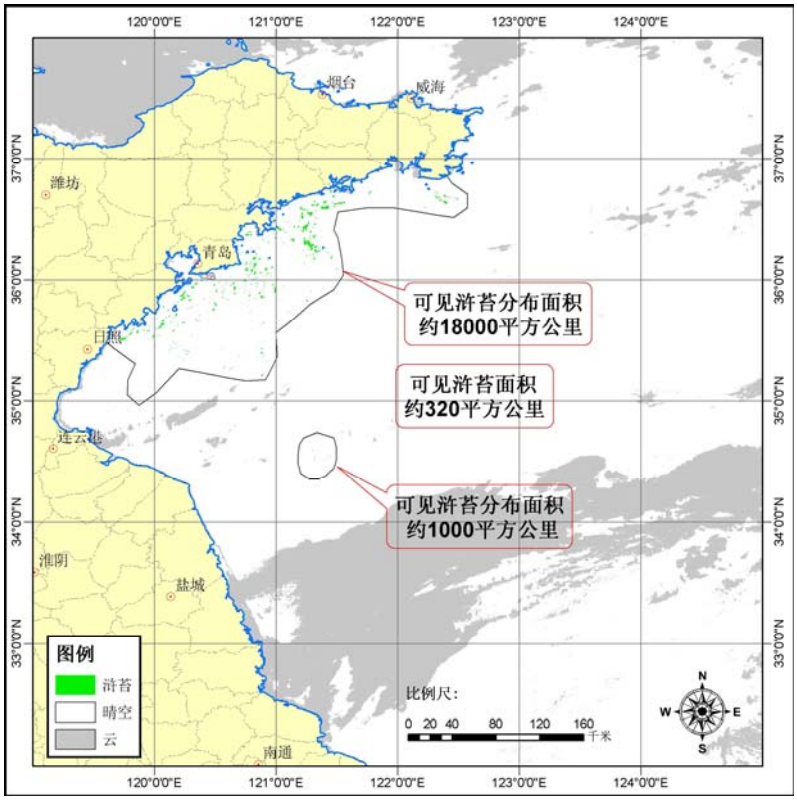


Figure4. The Alge Bloom information retrieved from COCTS image

4. Other applications

There many other application about HY-1 satellite data, such as red tide and estuary monitoring: Sediment distribution.