Marine Environmental monitoring with GF-1 satellite data

Bin ZOU, Lijian SHI, Qimao WANG
National Satellite Ocean Application Service
MNR, CHINA

Nov. 2018 YOKOHAMA

Objective:

- Gaofen (GF) is a series of Chinese High-Definition Earth Observation Satellite (HDEOS).
- It was launched on Apr. 26, 2013 on a CZ-2D rocket from China's Jiuquuan space center.
- Marine disaster monitoring with GF-1 data, give more detailed information.
Outline

1. Introduction
2. Sensors
3. Marine Application
4. Conclusions
5. Intro to the HY-1C ocean color satellite
1. Introduction

- China has developed Fengyun, Haiyang, Ziyuan and Huanjing satellite series. These satellites have made great contributions in weather forecasting, ocean monitoring, environment and disaster monitoring etc.
1. Introduction

- In order to improve the comprehensive capabilities of China's earth observation system, in 2010, the Chinese government approved to implement China's High-resolution Earth Observation System (CHEOS).

- Gaofen 1(GF-1) was launched on Apr. 26, 2013 on a CZ-2D rocket from China's Jiuquan space center.

- GF-1(02,03,04) 3 successor satellites was launched by CZ-4C on Mar. 31, 2018.
2. Sensors

- **PMS**: Panchromatic and Multi-spectral CCD Camera;
- **WFV**: Wild Field Camera.

<table>
<thead>
<tr>
<th>Load</th>
<th>Band No.</th>
<th>Spectral range (μm)</th>
<th>Spatial resolution (m)</th>
<th>Swath width (km)</th>
<th>Side-looking ability</th>
<th>Repetition cycle (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panchromatic &amp; Multispectral Camera</td>
<td>1</td>
<td>0.45～0.90</td>
<td>2</td>
<td>60 (2 Camera Stitching with)</td>
<td>±35°</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.45～0.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.52～0.59</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.63～0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0.77～0.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multispectral Camera</td>
<td>6</td>
<td>0.45～0.52</td>
<td>16</td>
<td>800 (4 Camera Stitching with)</td>
<td>±35°</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>0.52～0.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>0.63～0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>0.77～0.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Sensors

2m panchromatic/8m multispectral camera fusion image of the Gaofen-1 satellite, Beijing District in China, acquisition time: May 1, 2013
2. Sensors

16m multispectral camera image of the Gaofen-1 satellite. Yellow River Delta region in China, acquisition time: May 21, 2013
2. Sensors

Launch of a Long March 4C rocket took place at 03:22 UTC (11:22 Beijing time) on Saturday, carrying the Gaofen-1 02, 03 and 04 satellites into a Sun-synchronous orbit at an altitude of around 645 kilometres. The satellites carry with them 2-meter resolution CCD cameras, 8m resolution multi-spectrum imagers.
15 days coverage
2 days revisit
3. Marine Application

- Oil spill detection
- Sea ice classification
- Red tide detection
- Green tide detection
Oil spill detection

In recent years, with growing offshore oil exploration, transportation, various types of oil spill accidents occur frequently.

- Australia oil platform leaked in 2009
- Platform exploded in the Gulf of Mexico in 2010
- Oil spill of Penglai 19-3 platform in 2011
Oil spill detection

- A ship sinking accident happened on the sea area near the estuary of Dapu river in the Changli district of Hebei province on July 13, 2015 in the morning.

- On July 13 and July 14, we continuously used the GF-1 satellite images to tracking monitor the oil spills on the sea surface, and released two monitoring reports timely.

GF-1 image and corresponding oil spill monitoring thematic map on July 13, 2015
Oil spill detection

GF-1 image and corresponding oil spill monitoring thematic map on July 14, 2015
Oil and gas exploration and production and other maritime activities are rapidly increasing in the Bohai Sea. Since sea ice occurs every winter in this region, it poses serious threats to these activities. Sea ice hazard causes serious harm to aquaculture, marine navigation, offshore oil production and other activities in the Bohai Sea of China.
Data source for sea ice
Sea ice classification

Though merging 2m panchromatic image and 8m multispectral image, the RGB color images with 2m resolution can be used to get the sea ice information over the port zone. Figures show the different sea ice type over the Jinzhou port and BaYuQuan port on Jan. 10, 2014. These thematic maps supplied the detailed sea ice information for ship navigation.
Green tide detection

Shandong province suffered a severe green algae invasion in recent years. Although the green algae is not poisonous, it can hinder fishery industry and tourism in affected areas;
Green tide detection (detailed information)
Green tide detection

Satellite image and result
Green tide detection (drift)

With 16m multispectral images of WFV, we can get the green tide cover area. Figure shows the green tide detection results with GF-1 WFV (green color) and Aqua MODIS (red color) on Jul. 4, 2015. There is a time gap of 2 hours between GF-1 and Aqua images.
Red tide detection

- Harmful algal, be harmful to water quality and fisheries;
- It can be detected by satellite sensors because of “different color”, provides information for monitoring and forecasting;
Red tide detection

News (from internet)

Red tide in image of GF-1 on Nov. 22, 2014

Picture from plane
Red tide detection (with MODIS)

Red tide in image of MODIS on Nov. 22 and 25, 2014
4. Conclusions

- With the data of GF-1’s 2m /8m PMS and 16m WFV, the detailed information of oil spill, sea ice, red tide, and green tide was supplied.
- These information is very important for the disaster and pollution prevention and control over the coastal zone.
3rd China Ocean Color Sat (HY-1C) was launched on Sep. 7, 2018
我们需要和世界一起保护海洋
Five Main Payloads

**COCTS/UVI**
- 1km, 1day revisit
- Global monitoring all the time
- 8 visible and nir band
- 2 infrared band
- 2 ultra violet band for atm.corr
- High Dynamic Range

**CZI**
- 50m, 3 day revisit
- 4 visible and nir band
- High Dynamic Range

**AIS**
- Global ship AIS data

**SCI**
- on board Calibration
Bohai Sea
Sea of Japan
Okhotsk Sea
West of South Africa
Thank you!