Using HJ 1-A/B Satellite Imagery for Near-shore Sea Ice Monitoring in the Nanpu-Caofeidian Area, Bohai Bay, China

Hongying ZHOU, Wuyi YU, Yimin ZHANG ,Youyan ZHANG ,Xiaoping QI

Research Institute of Petroleum Exploration and Development,

Petrochina, Beijing, China

P.O. Box 910, 20# Xueyuan Road Beijing, 100083, P.R.China

zhouhys@petrochina.com.cn

Abstract

1. Introduction

Offshore oil and gas installations and related coastal infrastructure in and along the Bohai Bay area of China are frequently threatened by sea ice during the winter months, i.e December, Jamuary and February. Typical threats include the blockage of ports and shipping channels and damage to marine engineering facilities. Sea ice monitoring is important to facilitate safe operation of marine facilities and marine transport. For offshore oil and gas operations in the Bohai area space-borne remote sensing has become an important tool for wide area ice surveillance. There is also a need for detailed ice monitoring of specific coastal areas and installations at frequent intervals and sufficient spatial resolution. The formation of beach ice requires surveillance and monitoring at specific spatial and temporal resolution. In order to meet these requirements, this paper examines the use of CCD data from the recently launched Chinese HJ-1A/B satellite constellation in the Nanpu coastal region during the winter of 2008-2009. Moreover, multi-temporal ice condition change analysis is given with meteorological data.

2. Data Source

The Chinese HJ small satellite constellation is part of an advanced environment and disaster monitoring and warning system and improve national environment monitoring and disaster mitigation ability. In September, 2008 two optical satellites, named HJ-1 A/B were

launched into the same orbit. Their observations will be complemented by one SAR satellite (HJ-1 C), to be launched in 2010, effectively presenting China with imaging options during cloudy weather. The HJ-1A/B CCD data have a spatial resolution of 30 meters and a temporal resolution (revisit cycle) of four days; the swath width is 360 km.

In the near future, HJ SAR satellites will be launched. And the HJ SAR data have a spatial resolution of 20 meters and a temporal resolution (revisit cycle) of 24 hours. It will be a new data choice for ice monitoring in bad weathers.

Bohai Bay experiences sea ice conditions for three months per year, generally between December and March. Beach ice monitoring tasks involve synoptic, wide area surveillance, which requires specific spatial and temporal resolution. In order to meet these requirements, this paper examines the use of HJ-1A/B CCD data for detailed ice monitoring and analysis in the Nanpu coastal region during the winter of 2008-2009.

2. Methodology

A total of 20 cloud-free CCD images were collected from 29th November 2008 to 21st February 2009. A rapid, three-stage data processing procedure was based on object-oriented information extraction technology. The first step involved geometric precision correction, georeferencing and enhancement of the imagery. The second step involved sea ice information extraction by means of segmentation and classification; land-fast ice and ice pack vector features were then extracted automatically. The third step involved the generation of ice vector statistics and analysis with GIS software. The entire analysis process takes approximately 4 hours, which meets the need of near real-time monitoring and allows users to rapidly assess the latest ice development trends.

3. Results

With the rapid data processing procedure based on object-oriented extraction method, HJ CCD image interpretation and ice analysis was accomplished in a short time. The ice monitoring result provide timely and effective information for oil field.

Based on image analysis, classification and ice map, the following observations were made in conjunction with meteorological data for the winter period. The temperatures during

2008-2009 winter season were not uniformly low. The weather data indicate three major periods of very low temperature with significant growth of sea ice along the coast, each followed by higher temperatures that lead to ice melting.

During the initial ice period, which lasted throughout the month of December, ice was found to accumulate along Nanpu beach; the seaward ice edge followed the coastline to a maximum distance of 1.8 km. Land-fast ice also formed along both sides of the access road toward the artificial island, but not among three isolated islands. There is ice accumulation toward the east of the Caofeidian industrial area.

During the period of abundant ice in January, ice formation near the artificial island increases slightly. Under maximum ice conditions, densely packed and pancake-shaped ice dominates, with a maximum extent of 14 km parallel to the coastline, effectively blocking marine traffic to the islands. East of the Caofeidian industrial area ice extent and thickness increases along the coastlines of Yaotuo and Hatuo.

During the period of melting ice in February, the ice pack near the islands disappears, the amount of land-fast ice greatly decreases, and its maximum extent along the coastline decreases to 1 km. Ice in the Caofeidian industrial area melts completely, leaving only remnants along its northeast shore.

4. Conclusion

Remote sensing technology can provide offshore oil and gas operators in the Bohai area of China with timely and accurate information for detailed coastal ice monitoring. This study shows an example of multi-temporal use of HJ-1 A/B imagery to monitor ice conditions in the vicinity artificial islands with important infrastructure installations. HJ-1A/B CCD data, with 30m spatial resolution and four days temporal resolution was found to meet initial demands for detailed ice monitoring in a coastal region. Object-oriented information extraction technology effectively improved image classification accuracy and greatly shortened image interpretation time. The rapid data processing procedure within a four-hour time frame supported near real-time monitoring and analysis.

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