MICROWAVE REMOTE SENSING FOR MARINE MONITORING: AN EXAMPLE OF ENTEROMORPHA PROLIFERA BLOOM MONITORING

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ABSTRACT

Over the past several decades, microwave remote sensing has provided more and more meritorious information on observations of the earth, with special emphasis on diverse ocean phenomena, such as wave and wind field retrievals, currents, upwelling, oceanic eddies and fronts, oil or algae pollution, ship detection, sea ice monitoring, and so on.

In June 2008, a kind of algae called *Enteromorpha Prolifera* (E.P.) broken out so rapidly that the sea area near the Qingdao Olympic sailing center was invaded. Although E.P. is non-toxic and edible, the bloom of algae posed a potential threat to the Olympic sailing competition.

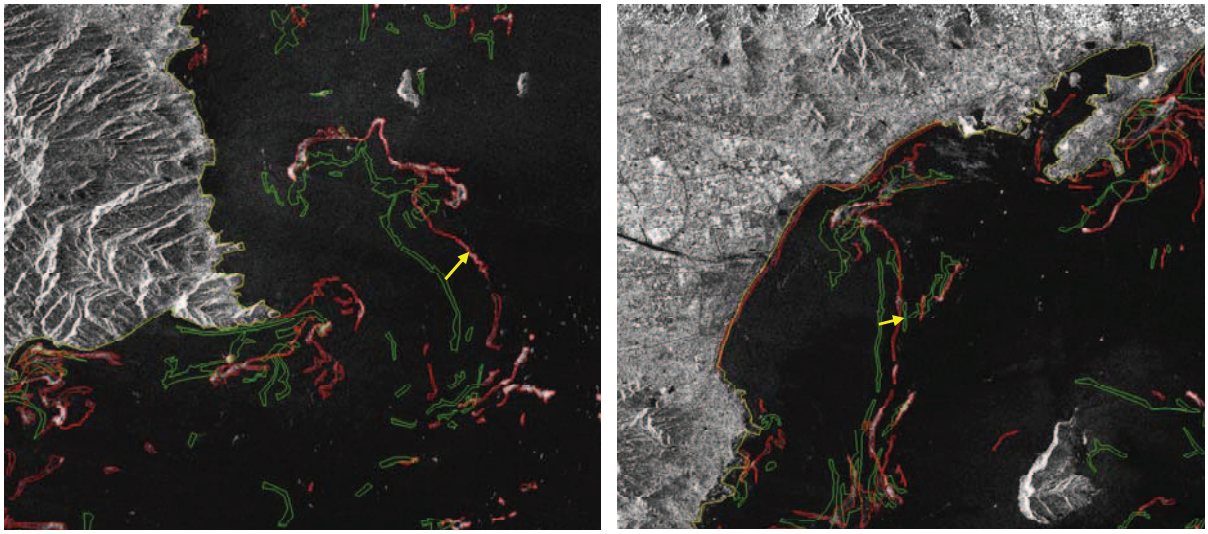
Synthetic Aperture Radar (SAR) technology plays an irreplaceable important role in algal blooming monitoring, day and night, under all weather conditions. The roughness of sea surface will be increased dramatically because of E.P. in sea. Hence, backscatter intensities received by satellite radar increases. And E.P. in SAR images represents bright strip features with special configurations. According to the backscattering characteristics, thresholding algorithm was used for E.P. detection and identification on SAR images. At the same time, morphological properties of E.P. were useful to reduce the false alarm rate.

The sea surface is affected by wind and wave, which makes the E.P. vary intensively over time. The environment of sea surface determines the drift trend of E.P., therefore, multi-temporal SAR images especially with high temporal resolution were used for E.P. dynamic monitoring and drift trend analysis. And wind products retrieved from SeaWinds scatterometer on QuickSCAT satellite were also used to analyze the spread of E.P..

Multi-temporal SAR data used in E.P. monitoring in Yellow Sea includes Radarsat 1, Radarsat 2, COSMO-SkyMed 1 and COSMO-SkyMed 2 data. COSMO-SkyMed 1 and COSMO-SkyMed 2 can provide X-band SAR data with high spatial resolution varying from 1 meter to 100 meters. And the repeat cycle of COSMO-SkyMed constellation is shorter.

Table 1 Detailed parameters of SAR data used for E.P. monitoring on 15 July 2008.

Satellite	Imaging time	Frequency (GHz)	Polarization mode	Resolution (m)	Incidence (°)
COSMO-SkyMed 1	5:58 PM 15 July	9.6	VV	20	40.0
COSMO-SkyMed 2	6:46 PM 15 July	9.6	VV	20	40.0



(a) **(b)**

Fig.1 Details of E.P. drifting within about 50 minutes. For region (a), the drift speed of E.P. is about 1.45 km/h, with direction of about 45° north by east, and for region (b), the drift speed of E.P. is about 0.77 km/h, with direction of about 65° north by east.

On July 15, 2008, two temporal COSMO-SkyMed images were obtained individually at 5:58 PM and 6:46 PM, Detection results of these two images are taken as an example in this paper. The spread trend of E.P. was analyzed through multi-temporal SAR images and other relative datum. To analyze the reason of E.P. drifting toward north during this time segment, wind information was collected from SeaWinds scatterometer at 6:36 PM 15 July, which showed wind in this region also blew towards north, in good accordance with monitoring results obtained using SAR images.

The drift speed and direction of E.P. were calculated through measuring the distance of certain E.P. targets during this time segment. For region (a) in Fig. 1, the drift speed of E.P. is about 1.45 km/h, with direction of about 45° north by east, and for region (b), the drift speed of E.P. is about 0.77 km/h, with direction of about 65° north by east.

There are many factors, such as radar frequency, polarization mode and so on, which influence the detection results of E.P. on SAR images. In addition, E.P. sometimes may not be detected by SAR, because the roughness

condition of the sea surface covered by E.P. is similar to that without E.P. in some ocean condition. So among all the sea surface covering with E.P., only those that influenced by E.P. seriously could be detected by SAR.

In conclusion, microwave remote sensing is proved to be an effective tool for marine algal bloom monitoring without weather limitations. According to SAR and scatterometer datum, E.P. could be detected and the spread trend could be forecasted. Multi-temporal SAR images especially with high temporal resolution could be used for dynamic monitoring effectively, and multi-source microwave remote sensing data would help much more for marine environment monitoring.

Key word: Synthetic aperture radar; Enteromorpha Prolifera; environment monitoring; scatterometer

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