AN EXPERIMENT FOR OIL SPILL RECOGNITION USING RADARSAT-2 IMAGE

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ABSTRACT

Oil spills revealed as a set of dark patches in radar remotely sensed imagery physically due to its damping effect on capillary waves and short gravity waves on the sea surface which are dominant in the process of Bragg scattering[1,2]. SAR is therefore widely used in identifying oil spill as its high spatial resolution and ability of imaging both in cloudy day and night. But, unfortunately, the algae (e.g. the Enteromorpha Prolifera) on the sea surface, the sea region controlled by local wind stress with low wind speed, and the presence of floating organic slicks or natural seeped oil slicks may interfere the identifying of oil spill in SAR images. Moreover, the impacts of the releasing crude oil that with different chemical composition and thus with different physical properties (e.g. density, viscosity, surface tension, diffusibility etc.) on marine environment will be different. For example, heavy crude oil tends to have larger density and smaller fluidity. Therefore it contaminates ocean ecological system seriously and will be cleaned up difficultly. In recent years, many of operational SAR such as TerraSAR-X, Radarsat-2, and Cosmo-SkyMed constellation etc., have been launched successfully. The exclusive property of these advanced microwave remote sensor is its polarimetry and its high spatial resolution (up to 1m). To investigate the discrimination between different kind of crude oil and look-alikes by using Radarsat-2 Fine Quad-polarized SAR imageries, an oil spill in situ experiment with the satellite flying over simultaneously was implemented in the South China Sea on Sep 18, 2009.

To acquire a confident evaluation of the features of different substances (e.g. oils with different composition, algae, and look-alikes etc.) in a SAR image, the sea state should be representatively moderate. According to the information about wind stress and significant wave height, etc. which

retrieved from archived data of microwave scatterometer QSCAT and radar altimeter Jason-1 [3] in the South China Sea, the September was finally selected as an appropriate time window. To make a comparison between man-made crude oils and organic excretions that often revealed as look-alikes, the experiment site was selected nearby a popular fishing region in 18°N, south off the coast of the China's Hainan Island. In this investigation, three kind of oil with different viscosity were used to simulate oil spill on the sea surface: heavy oil (gear oil), moderate viscous oil (lubricating oil) and light oil (soybean oil). In addition, a RADARSAT-2 imagery of Fine Quad-polarized mode (~8m spatial resolution, 25Km swath, full polarization, C-band) had been planned to obtain. In the process of the experiment, gear oil (5L) had been firstly poured upon the sea one hour before the satellite passed. Fifteen minute later, the lubricating oil (5L) and soybean oil (5L) were spilled successively with fifteen-minute interval between. The environment parameter such as wind speed/direction, ocean current velocity/direction, sea surface temperature (SST), significant wave height (SWH), etc. were in situ recorded.

The central conclusion of this investigation could be summarized as follows. In the moderate-level sea state (wind speed of ~3m/s, SWH of 0.1m~0.2m, ocean current velocity of ~1m/s), the floating of oil spill is modulated by both wind and ocean current, but the modulation effect of ocean current is dominant. This is a contrast with the popular 2% effect [4] that evaluates the impact of strong wind on oil spills in a high-level sea state. The cross polarization channels of SAR image could be engaged to mask background sea region. Because it was found that the contrast between the sea and the dark area in the cross polarization channel is less than in the co-polarization channel. Finally, the NRCS of oil spills with different kinematic viscosity that retrieved from calibrated image in VV polarization is in good agreement with that simulated by the Viscous Sea Backscattering Model based on the extended gravity-capillary wave spectrum density function reported in the literature [5-7]. The average of the phase difference [8] between co-polarization and cross polarization $\overline{\varphi_{vv-vh}}$ can be served as an identifying indicator for man-made crude oil and look-alikes.

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