ALOS-PALSAR POLARIMETRIC SAR DATA TO OBSERVE SEA OIL SLICKS

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ABSTRACT

Nowadays there is a general consensus that the extra-information provided by the polarimetric Synthetic Aperture Radar (SAR) data enhance the capabilities of identifying and classifying the scene scattering behavior [1]. A fully polarimetric SAR transmits and receives two orthogonally polarized fields and, as result, gets the scattering matrix **S** for each resolution cell. Hence, this measurement process, taking into account the vectorial nature of the scattered field, allow retaining all the information in the scattered wave and describing the polarimetric properties of the observed scene.

In January 2006, the Advanced Land Observing Satellite (ALOS) was launched by Japan Aerospace Exploration Agency (JAXA). It carries on board the Phased Array type L-band Synthetic Aperture Radar (PALSAR) which is the first space-borne full-polarimetric radar utilizing horizontally (h) and vertically (v) polarized microwaves both in transmission and reception. As a matter of fact, PALSAR measurements, acquired in the polarimetric mode, can serve as useful data source to provide additional information for environmental remote sensing applications.

Within this context, in this study an electromagnetic approach is proposed for exploiting polarimetric information for sea oil slick observation in L-band PALSAR data. Sea oil pollution is a matter of great concern since it affects both the environment and human health. Oil slick detection is fundamental to effectively plane countermeasures and to minimize pollution effects and the SAR is unanimously recognized, under low to moderate wind conditions, as the most important imaging sensor for a synoptic and effective oil slick observation since its all-weather day and night capabilities [2]. In fact, the presence of a surface slick, reducing the signal backscattered to the radar antenna, generates a low-backscattering area which, in SAR images, appears as a dark area [3]. Following this rationale image processing techniques are commonly employed on single-polarimetric SAR data to detect dark areas [3]. However, other physical phenomena, such as biogenic films, low winds..., can generate low backscattering areas (look-alikes) in SAR images. Thus, oil slick detection and classification techniques are still an open issue. First investigations on sea oil slick observation by means of polarimetric SAR data were generally unsatisfactory [4], only in recent times the usefulness of fully and partially polarized SAR measurements has been demonstrated for the C-band [5]-[8].

The approach here proposed is based on the different sea surface scattering mechanism expected with and without surface slicks. It has been demonstrated in [6]-[8] that though the sea surface scattering follow a Bragg or tilted Bragg scattering mechanism, the presence of a surface slick, depending on its damping properties, may lead to a completely different and non-Bragg scattering mechanism. In this study, following this theoretical rationale, polarimetric information are exploited for sea oil slick observation. In detail, provided **S**, the Mueller scattering matrix (**M**) is constructed, and a physically based filtering technique, dubbed *Mueller filtering* [7], is applied in order to detect oil slicks. Successively, the filtering results are verified by the analysis of the slick-free and slick-covered co-polarized signature and polarimetric entropy (H), performed by using the Kennaugh matrix (**K**) and the coherence matrix (**T**), respectively, following the guidelines developed in [5],[8].

Experiments are accomplished on a meaningful set of Level 1.1 L-Band PALSAR polarimetric data. The nominal slant (ground) resolution is 9.4 (26.0) meters in range and 4.5 meters in azimuth. The Level 1.1 data, although affected by speckle, are characterized by the finest spatial resolution and, thus, have to preferred for oil slick observation purposes. However, is must be noted that converting **S** into **M** implies an ensemble averaging process which reduces the available spatial resolution. In this study a 7x7 moving window is considered since it represents a good compromise between speckle reduction and texture preservation.

Experimental results (see Figs. 1-5) show the effectiveness and the usefulness of polarimetric L-band SAR data for sea oil slick observation and allow underlining the importance of fully polarimetric L-band SAR data for oil slick observation.

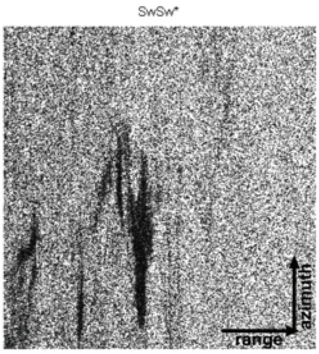

Fig. 1. module of the SLC ground projected VV SAR image to the acquisition of August 27, 2006, ALPSRP031440190, in which an oil slick is present.

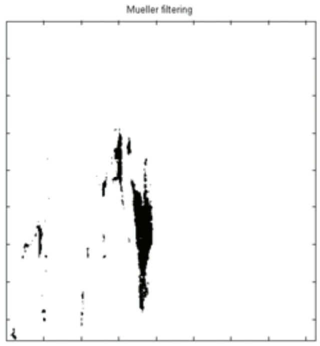

Fig. 2. Mueller filter output relevant to the sub-image of data set ALPSRP031440190.

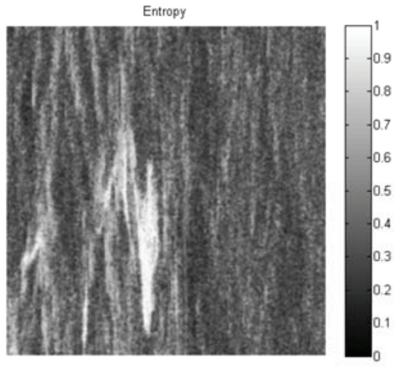

Fig.3. Entropy image relevant to the SAR data shown in Fig.1.

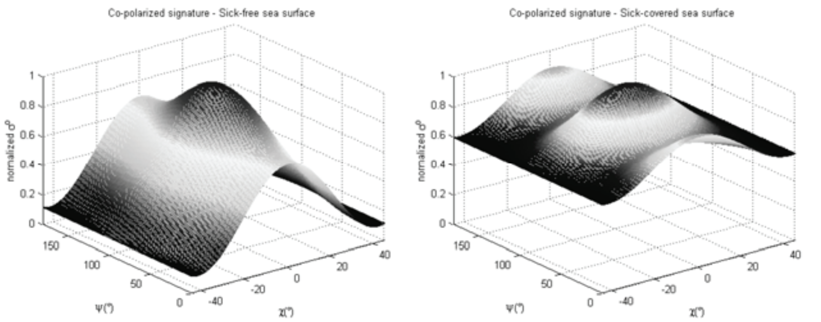

Fig. 4. Polarization signature relevant to the slick-free sea surface (left); polarization signature relevant to the slick-covered sea surface (right).

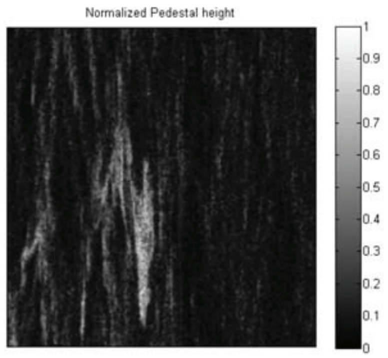

Fig.5. Pedestal image relevant to the SAR data shown in Fig.1.

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