A UNIFIED POLARIMETRIC APPROACH FOR SAR SEA OIL SLICK OBSERVATION

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ABSTRACT

A fully polarimetric Synthetic Aperture Radar (SAR) measures the scattering matrix for each resolution cell. Once the latter has been measured, the Mueller scattering matrix can be constructed. The latter, relating the scattered Stokes vector to the incident one, is able to describe both fully- and partially-polarized scattered fields and, therefore, it is the most general way for dealing with polarimetric sea surface scattering.

Recently, it was demonstrated that both fully- and partially-polarimetric L- and C-band SAR data, once properly modeled, can be successfully employed for sea oil slick observation purposes [1]-[5]. However, tailored approaches which, based on either fully- [1]-[4] or partially- [5] polarimetric SAR data, consider some features related either to the scattering matrix or the Mueller matrix or the Coherence matrix, were developed and demonstrated to be able both to observe oil slicks and distinguish them from biogenic slicks.

In this study, a novel unified theoretical framework to describe the polarimetric sea surface scattering with and without surface slicks, entirely based on the Mueller scattering matrix, is proposed. The theoretical model predicts different scattering mechanisms depending on the damping properties of the surface slicks. Dealing with slick-free or biogenic slick-covered sea surface a Bragg scattering mechanism is expected, while, a non-Bragg scattering mechanism is expected in case of oil slick-covered sea surface [2]-[5].

Following this rationale, the Mueller scattering matrix is physically read in terms of slick-free and slick-covered sea surface scattering mechanisms, through the analysis of some Mueller based polarimetric descriptors, i.e. the degree of polarization and the statistics of the phase difference.

Experiments, accomplished on SIR-C/X-SAR C-band Multi Look Complex (MLC) and on ALOS PalSAR L-band polarimetric SAR data, confirm the consistence of the proposed unified polarimetric framework for SAR sea oil slick observation purposes and, moreover, they allow sorting the effectiveness of the polarimetric SAR sea oil slick detection approaches depending on the kind of polarimetric data available (fully or partially polarimetric SAR data).

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