The bistatic electromagnetic signature of heterogeneous sea surface: Study of the hydrodynamic phenomena

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ABSTRACT

The main goal of the development of new radar systems is to improve the characterization of the observed target, which has to be identified in a complex and evolutionary medium, like for marine environments (seas, oceans and large lakes). To solve the problem of detection and identification of target above seas surfaces or sea clutter, it is very important to finely quantify the effects of bistatic electromagnetic reflection by the rough sea surfaces. To date, many research works have been focused to model the electromagnetic scattering of sea surfaces. Indeed, in one hand different models based on the geometric description of the sea surface [El Fouhaily, Pierson-Moscowitz, ..] and on the other hand different electromagnetic models, Kirchhoff approximation (KA SPM, SSA, SST, WCA, ...) [1], [2], [3],[4], [5] .

In marine environments and particularly in coastal areas, there are different physical phenomena or object which can change the characteristics of the seas surface. For example, we may find ship wake which can change the geometric characteristics of the surface. Also, we may find some pollutant like petrol or oil, which change the dielectric constant of the surface. The breaking wave is another complicate phenomenon, which can change completely the features of the sea surface. All these phenomena are showed in the following Figure 1.

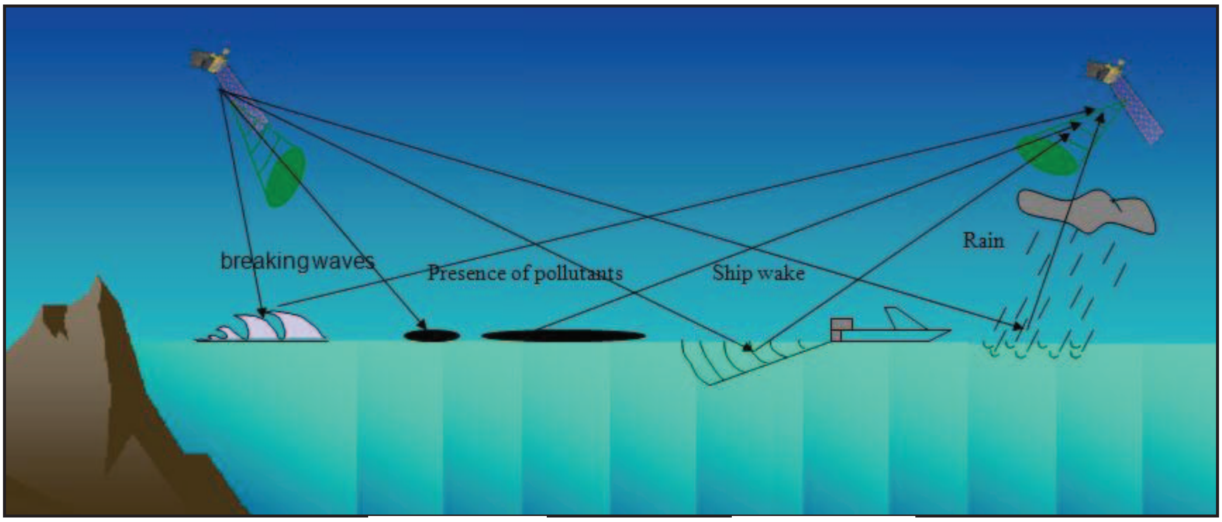

Fig 1: scene of the heterogeneous ocean surface

In the recent literatures, we have found that these different phenomena have been in general separately studied (mono-static case). And also, to the best of our knowledge there are not research works, which analyse the interaction between these phenomena and their contribution to the scattering process. Therefore the aim of this work is to study the scattering of the heterogeneous ocean surface, with considering the contribution of the different phenomena.

This work aims to find a methodology to process, then to estimate the electromagnetic signature of a heterogeneous ocean surface with considering the hydrodynamic feature as wave breakers [6], [7], [8]. Indeed, for each kind of sea surface we will use the adequate the spectral description, perhaps tow different. Then, we use the suitable model for each feature of the sea surface. For example, to analyze the electromagnetic signature of pollutants (oil or petrol), we will use the modified Elfouhaily spectrum depending on the type of pollutant, which characterize the dielectric feature of the sea [9], [10], [11]. And to analyze the electromagnetic signature of ship wakes which affect the sea surface geometry Elfouhaily, Fung and Lee [12], [13].

However, we will use the Kudryavtsev spectrum to analyze the hydrodynamic feature, which presents breaking waves [14], [15], [16], [17], [18], [19]. Finally, for coastal areas we will use the Gaussian spectrum [20], [21].

In this paper, we will present the preliminary results of the analyzing of the electromagnetic signature of the heterogeneous ocean surface by using in the same time different spectral models of the surface. Firstly, we will present the sensitivity of the electromagnetic signature to the different phenomena separately in bistatic case. Then, the simulation of the different model with considering the feature of each phenomenon will be plotted. This first study will help us in the future, to classify a heterogeneous ocean surface by using the polarimetric scattering matrix from one side and from other side to estimate the sea surface parameters and metrological parameters, as the electric permeability, the salinity and the wind parameters (direction and energy).

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