CORRELATION BETWEEN THE NRCS AND THE WIND SPEED OVER SEA IN BOTH MONOSTATIC AND BISTATIC CONFIGURATIONS

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1. INTRODUCTION

Weather forecasting models require measurements of wind speed and direction, as well as another parameters, over the global ocean surface [1]. Since the required instruments on many ocean buoys would be impossibly expensive to deploy and maintain, the retrieval of such informations is performed through a wide range of onboard instruments including active and passive sensors operating in various wave length. The objective is to find out how these statistical properties of the sea surface can be extracted from scattered radar signal. Hence, any attempt to recover sea state parameters rests with the ability to understand the scattering processes for general sea state condition sand direction of incidence. In particular, quantifying the effect of wind speed on the scattering coefficients versus the incident angle is crucial to the design of a system that would optimize the number of reflections captured and processed by the sensor [2].
In this context, the basis for relating radar measurements to wind vector is that the normalized radar cross section (NRCS) is dependent on the surface roughness and that in the ocean, the surface roughness is mainly caused by wind generated surface waves.

In this paper, we study and analyze the correlation between the NRCS and the wind speed over the sea surface in both monostatic and bistatic configurations. In our investigation we paid special attention to particular behavior in this correlation. The NRCS numerical calculations were made by using the first order of the Small Slope Approximation (SSA) scattering model [3, 4] and by assuming the Elfouhaily *et al*. [5] surface-height spectrum for fully developed seas.

2. CORRELATION IN MONOSTATIC CONFIGURATION

The backscattering configuration is obviously of utter importance in many applications as classic radars, satellite SAR images and others electromagnetic sensor systems. Therefore, the numerical results in scientific references are almost solely given for backscattering problems.

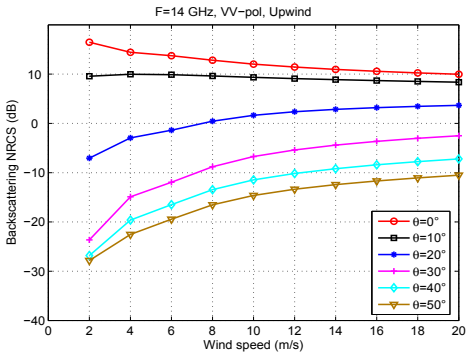


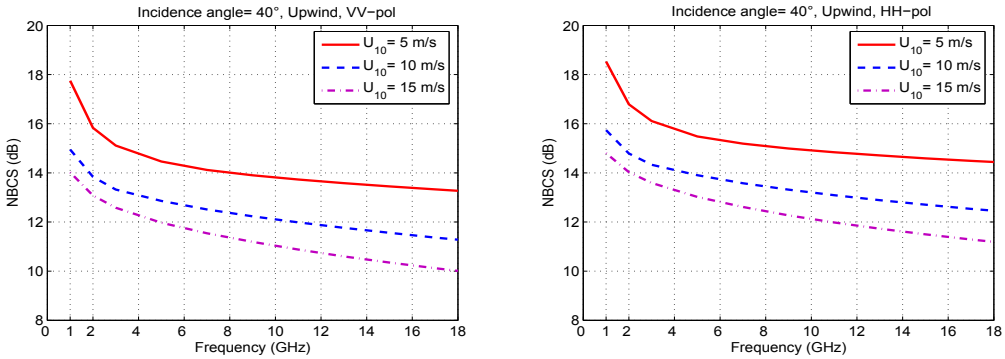
Fig. 1. Backscattering NRCS predicted with the SSA model for different incident angles $\theta \in \{0° - 50°\}$

In figure 1 we deduce the velocity wind influence on the electromagnetic scattering by the sea surface for different incident angles $\theta \in \{0° - 50°\}$ for upwind direction. The frequency is fixed to 14 Ghz (K_u band). For $\theta = 0°$ (nadir direction) the NRCS decreases with the wind speed. This observation appears as logic since the surface becomes more roughness, so the reflected signal energy in the same direction ($\theta = 0°$) weakens.

Contrary to this behavior, for $\theta = 20 - 50°$, the NRCS increases with the wind speed. This is due to the fact that in these geometrical configurations, the Bragg mechanism of scattering becomes significant. As this mechanism is sensitive to capillarity waves, when the wind speed increases, the interaction of electromagnetic signals with capillary waves tends to amplify the Backward intensity for this angle range ($\theta \in 20 - 50°$).

However, the case of $\theta = 0°$ presents a particular behavior where the NRCS is quasi constant, then independent to the wind speed. This case can be exploited in an appropriate application when the wind speed is completely unknown.

3. CORRELATION IN BISTATIC CONFIGURATION



(a) VV polarization (b) HH polarization

Fig. 2. Bistatic NRCS on the scattering along the specular direction for $40°$ incidence angle at three wind speeds $\{5, 10, 15\text{m/s}\}$, (a) VV-polarization and (b) HH-polarization

In order to provide a global view, we plot, in figure 2, the bistatic NRCS ($\equiv$ NBCS) variations along the specular direction for $\theta = 40°$ incidence angle as a function of both the radar frequency value (1- 18 GHz) and the wind speed U_{10} (5, 10 and 15 m/s) for VV- and HH-polarizations. As is apparent in this figure, for forward scattering (particular case of bistatic configuration), and unlike backscattering case, when the wind speed increases, the NBCS values decrease.

More simulations and discussions on the NRCS predicted with SSA model in the fully bistatic case will be shown in the final paper, and some comparisons with empirical and experimental results will also be presented.

4. REFERENCES

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