BACK SCATTERING FROM FRACTAL SURFACE OF SEA

Y. Yan

Department of Physics
Yantai University, 264635
Yantai, Shandong; China

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Abstract: In this paper, we use a fractal function to model the surface of sea, and fractal dimension is also an appropriate descriptor of roughness of sea surface. The back scattering characteristics of fractal surface of sea are analyzed based upon the Kirchhoff approximation. It is shown that the band limited Weierstrass spectrum function is a potential candidate for modeling rough fluctuations of sea surface.

Key words: sea surface, fractal spectrum, back scattering, Weierstrass function

1. Introduction

The problem of electromagnetic wave scattering from the surface of sea has been become increasing important in recent years, particularly in the areas of remote sensing and detection. The surface of sea, in general, randomly varying in time and space so that the amplitude and phase of the electromagnetic wave may also fluctuate randomly in time and space. The recently researches have been presented that turbulence of sea
surface shows the characteristics of self-similarity. A possible method of describing surface of sea is through the use of power spectrum\(^1\). In this paper, we use a fractal function to model surface of sea, and fractal dimension is also an appropriate descriptor of roughness of corrugated surface. The relationship between the back scattering behavior and fractal characteristics of sea surface is studied based upon the Kirchhoff approximation. Finally, some discussions are given about back scattering from fractal surface of sea.

2. Scattering from surface of sea

The surface of sea is rough in varying degrees, and this roughness affects the propagation and scattering characteristics of electromagnetic wave. A wave incident on a rough surface of sea is scattered in all directions. When the rough surface of sea is in motion, the scattered wave contains Doppler shifted frequency components.

In rough surface scattering, it is important to recognize that the roughness of a surface depends on the wavelength and the direction of wave propagation and scattering. A central problem in rough surface scattering is to find the scattering cross per unit area of a rough surface. The perturbation method is applicable when the phase difference due to the height variation is much smaller than \(2\pi\), and the slope is much smaller than unity. Mathematically, we can write

\[
|k f \cos \theta| \langle 1, \quad \left| \frac{\partial f}{\partial x} \right| \langle 1, \quad \left| \frac{\partial f}{\partial y} \right| \langle 1, \quad (1)
\]

where, the height of a rough surface is given by \(z = f(x, y)\), and \(\theta\) is the incident angle.