A New Fractal-based Approach to Model Scattering from Natural Surfaces with Hurst Exponent H(R)

A. K. Sultan-Salem and G. L. Tyler
Stanford University, USA

Natural surfaces have properties, such as the root-mean square (RMS) slope, which depend on the horizontal scale, R, over which they are estimated. Fractal surface models mimic these observed scale-dependent characteristics and, thus, have come to play an important role in the study of wave scattering from different types of natural rough surfaces. Franceschetti et al. [1], for instance, used the Kirchhoff approximation and a fractional Brownian surface model to develop a practical fractal-based scattering law. Their law subsumes as special cases the Hagfors and Gaussian scattering laws, widely used to model scattering from planetary surfaces, when the Hurst exponent parameter, H, of the fractal model equals 1/2 and 1, respectively. The exponential scattering law, which is a better modeler of the scattering behavior from certain surfaces, is not covered by the fractal-based scattering law of Franceschetti et al., however. In order to find a fractal counterpart to the exponential law, we allow the Hurst exponent to be a function of horizontal scale, $H(R)$. Given an exponential scattering law, whose parameters are obtained through fitting backscatter radar cross section observations, an integral equation is solved, via the Hankel transform, to obtain the Hurst exponent and, consequently, the RMS slope of the surface as a function of horizontal scale [2]. This approach can be extended to provide a scale-explicit parameterization of surfaces for which near-nadir quasi-specular observations are available, and whose scattering behavior is modeled by any linear combination of the aforementioned scattering laws or any others that have a Hankel transform.

REFERENCES

1. Franceschetti, et al., *IEEE Trans. Antennas Propag.*, 1405–1415, Sept. 1999.
2. Sultan-Salem, A. K. and G. L. Tyler, "Generalized fractal-based laws for scattering from planetary surfaces: a unifying scale-explicit paradigm," *J. Geophys. Res.*, in press.