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Application of fractal-based scattering laws to Venus data

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Fractal geometry has become increasingly attractive both as a model for physical surfaces and as the basis for a new generation of radio-wave scattering models. A family of fractal-based scattering laws derived using the fractional Brownian (FB) surface model exhibits an explicit dependence of the root-mean-square (rms) surface slope on lateral scale. This contrasts with scattering laws based on classical surface models for which no explicit scale-dependence is available. In addition to the surface rms slope parameter and reflectivity, scattering by FB surfaces is characterized by a third parameter, the Hurst exponent, which expresses the relative distribution of roughness with scale, thereby providing a second measure of the surface roughness distribution with scale. Magellan altimeter data were previously inverted to obtain radar-cross-section vs. angle measurements which were then fitted using classical exponential, Hagfors, and Gaussian scattering laws to produce estimates of the surface reflectivity and rms slope (Tyler et al., J. Geophys. Res., 97(E8), 13,115–13,139, August 1992). The application of fractal-based scattering laws to Magellan data shows that while they outperform the Hagfors and Gaussian scattering laws in terms of significance-of-fit and explicit scale information, they fail to perform as well as the exponential scattering laws at some surface locations. No single value of the Hurst exponent can generate the behavior of the exponential scattering law, though the latter is a better representation of approximately two thirds of the Venusian surface. Modifications of the fractal-based scattering laws are currently under investigation to extend their domain of applicability.