Stochastic Green's Functions for Rough Surface Scattering

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One of the important quantities in rough surface scattering is the scattering amplitude and the scattering cross section per unit area of the rough surface, and this is normally obtained when a plane wave or a tapered beam wave is incident on the surface. However, recent interest in LGA (Low Grazing Angle) scattering and scattering by objects located close to the rough surface has lead to renewed interest in considering incident waves which are more general than a plane wave. This requires the study of Green's functions which contain all propagating and evanescent modes and the coupling between the rough surface and the random current on the deterministic object. This paper presents a review of some recent theoretical developments in rough surface Green's functions as applied to LGA and object scattering.

First, we consider the first and second moments of Green's functions when both the point source and observation point are located close to or on the rough surface. In the perturbation approximation, the coherent Green's function satisfies the Dyson equation and propagates over the effective impedance surface which includes the rough surface effects. The incoherent Green's function satisfies the Bethe-Salpeter equation and gives the effective scattering cross section which includes the propagation characteristics and is distance-dependent. We discuss the HH/VV ratio for LGA, enhanced backscattering, formulation of the surface radiative transfer equation, and scattering by distributed wedges in the high frequency approximation.

If an object is located close to the rough surface, the currents on the object are random and satisfy the stochastic integral equations involving the fourth-order moments, including the coupling between Green's function and the current. Green's function includes the effects of coupling between the object and the rough surface. If we make further assumptions, such as, circular Gaussian, we can decouple Green's function from the current distribution. If the object size is much smaller than the correlation distance of Green's function, the scattered field at the source point is given by the "double passage" Green's function, and the equivalent RCS reveals the enhanced backscattering of a factor of 2 due to multiple scattering. In addition, we discuss several outstanding problems, including the impedance of a dipole above the rough surface, the objects on or below the rough surface, the effects of the object resonance, and the time-domain considerations.