UHF Backscatter from Forests with an Underlying Rough Surface

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ABSTRACT

This paper considers backscattering of UHF radar signals from forests with rough underlying soil surfaces. The effects of specular and non-specular scattering from the tree trunks and their interaction with the rough surface are considered. It is shown that as the surface roughness increases, there is a gradual decrease in the specular backscatter and an increase in the non-specular component. The importance of the non-specular double bounce contribution has been validated by comparing the model calculations with NASA JPL AIRSAR, P and L band data over the Howland forest in Maine USA.

FOREST MODEL DEVELOPMENT

In this paper the radar backscatter from the trunk-rough surface interaction will be computed and its importance assessed. Traditionally, radar backscatter from forests has been decomposed into three types of scattering effects: volume scatter, trunk-ground interaction and surface scatter. The volume scatter comes mostly from branches and needles (leaves). The trunk–ground interaction contribution is due to an incident wave that is *specularly* reflected from the trunk and then *specularly* reflected from the average ground surface. Finally, the surface scatter results when incident energy is directly backscattered from the rough ground surface. In mature forests with long trunks, the trunk–ground interaction term can be large since the long cylinders have a high gain. As the surface roughness increases, however, the average reflection coefficient of the surface rapidly becomes smaller. This decreases the size of the interaction contribution. In this work the importance of *non-specular* backscatter from the trunk and rough surface interaction will be examined [1].

The forest model consists of a single layer of vertical trunks interspersed with branches and needles whose orientation statistics are prescribed. The forest floor is represented as a rough surface with a given rms height and correlation length. The backscatter can be computed by using a first order iteration to the vector transport theory or by employing the distorted Born approximation (DBA). Both methods will be employed and their results compared. The DBA will account for both incoherent and coherent contributions while the transport results will contain only incoherent contributions. In both methods terms involving non-specular reflection from the tree trunks and rough surface will be retained

RESULTS AND COMARISON WITH DATA

Results have been computed for both like and cross polarized backscatter in the frequency range from 200MHz to 2 GHz. Both the traditional contributions and the non-specular trunk ground terms have been obtained. The results show that as the surface roughness increases, the specular trunk ground effect decreases while the non-specular trunk ground contribution increases. Thus, even in the presence of forests with rough underlying surfaces, forest backscatter can still exhibit strong trunk-ground interaction terms. This is important for remote sensing purposes since these terms are sensitive to forest height and soil moisture.

Finally, the model was used to calculate the backscatter from a hemlock forest located in Howland, Maine USA. This site which had a rough ground surface was over-flown during early September, 1989 by the NASA JPL AIRSAR. Multi-polarization SAR data was recorded at P, L and C band frequencies. In the same time period, the forest stand and ground characteristics were measured in detail. Use of the forest site parameters in the model resulted in good agreement with experimental values. The non-specular trunk-

ground contribution was the dominant term in the backscatter from the stand; thus agreement would not have been possible without this contribution

REFERENCE

[1] R. Lang, "Scattering from a layer of discrete random medium over a random interface: application to microwave backscattering from forests," Waves Random Media, vol. 14, pp. S359-S391, 2004