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RADAR SCATTERING AND SOIL MOISTURE

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Research is being conducted on microwave scattering from vegetation. The objective is to develop techniques for measuring parameters of the vegetation canopy (such as biomass) needed for understanding global biogeochemical cycles and to develop techniques for correcting microwave measurements of soil moisture for the effects of the vegetation canopy. Measurements of vegetation and soil moisture are important for understanding the environment on a global scale. For example, moisture in the soil is an important, highly variable, element in the global hydrologic cycle. The hydrologic cycle, in turn, is strongly coupled to weather and climate through moisture (and energy) fluxes at the surface. The amount and distribution of vegetation is an important element in biogeochemical cycles; and knowledge of both the vegetation canopy and soil moisture is of practical importance in agricultural management.

This research is a cooperative effort involving the Microwave Sensors and Data Communication Branch (Code 675) and the Hydrological Sciences Branch (Code 624) at Goddard and the Hydrology Laboratory at the U. S. Department Agriculture and the Department of Electrical Engineering at the George Washington University. Significant progress has been made in developing theoretical models for propagation and attenuation in the vegetation and this theory is being tested using microwave radars and radiometers at specially prepared fields at the nearby USDA Research Center in Beltsville, Maryland.

The theoretical work is based on a discrete model for the vegetation. In this approach, the vegetation is modelled as a random collection of individual objects (e.g., leaves and stems) and the solution is expressed in terms of the scattering amplitude and the location and orientation of the individual objects. The approach depends on having accurate models for the scattering amplitude of the individual objects but has the advantage that the results are expressed in terms of quantities such as plant geometry and orientation statistics which are easily related to the biophysical parameters of the individual plants. The Goddard research team has had significant success using rods and disks to model the plant parts (leaves and stems) and employing a distorted Born approximation to treat the multiple scattering problem. Inversion algorithms for the plant parameters have recently been developed using these solutions.

The experimental work is designed to test the theory and verify the inversion algorithms. This is being done with a three frequency radar (L- C- and X-band) which makes measurements at several polarizations (HH, VV and HV) as a function of incidence angle. This radar was designed for GSFC by the Texas A & M University and is in its first season of operation. The crop most studied to date has been soybeans. Studies have been made to determine plant geometry and orientation statistics needed for the models and microwave radiometric measurements have been made over the canopy and are being compared with theory. Combined radar and radiometric measurements are being prepared for the coming season (Summer 1988).