Coherent Bistatic Scattering Model for Vegetated Land Cover in Support of Soil Moisture Retrieval

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Soil moisture is a key parameter in controlling the partitioning of water between the atmosphere and the land surface, and improving our knowledge of the global water and energy cycle. Soil moisture impacts many areas of human interest such as drought, flooding, and weather. Development of reliable soil moisture retrieval techniques is therefore a subject of great interest.

Most of the today's airborne and spaceborne soil moisture missions use mono-static radars, which only measure the scattered wave in the backscatter direction. However, a more general approach is to extend the observation scenario to utilize bi-static multi angle measurements. Taking advantage of bi-static or multi-static observations allows the opportunity to measure the scattered field in various independent directions, creating a data space of higher dimensionality and possibly producing more accurate retrievals. As an illustration of multi-static observation techniques, the L-band GNSS/GPS reflected signals can be utilized in order to retrieve soil moisture over different types of land covers. Although several recent papers have addressed soil moisture retrieval methods over bare or low-vegetated surfaces with acceptable results, it may be possible to estimate soil moisture over forested areas and reach higher soil moisture estimation accuracy by applying proper bi-static scattering models.

This paper will present a coherent bistatic forward scattering model at L-band and P-band for various terrain types and vegetated land covers including forests. In this model, the three major scattering categories of contribution include direct ground scattering, vegetation volume scattering, and the scattering due to the interactions between the vegetation layer and ground. The crown layer of the forest is treated as vertically (trunks) and randomly oriented (branches, leaves) dielectric cylinders over the ground. Moreover, the forest floor is modelled as the dielectric random rough surface and the Small Perturbation Method (SPM) is used up to second order for the direct ground contribution. The double bounce (trunk-ground, branch-ground) bistatic scattering cross section is calculated by a combination of SPM and Kirchoff models. The total cross section can be determined by superimposing the RCS for each of the stated contributions. The presentation will include an overview of the model, cross section simulation results for various forest types, and a sensitivity analysis with respect to soil moisture for different forest structure types and densities.