MODELING THE MULTIFREQUENCY EMISSION OF FORESTS AND THEIR COMPONENTS

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ABSTRACT

The problem of forest emission modelling is receiving an increasing attention. This research has been stimulated by the development of space projects, such as SMOS, using lower microwave frequencies for soil moisture applications. Since a significant fraction of land pixels are covered by forests, at least partially, simulating their emission is important to derive reliable retrieval algorithms. Most of the studies have been focused on L band, which is suitable for soil moisture applications, and is also sensitive to biomass variations. However, also simulations at higher frequencies have some importance. In fact, the emissivity at higher frequencies contain information about crown properties, satellite data are already available, and the resolution problem is less severe.

In this paper, the multifrequency emissivity of forests is simulated by using a discrete model. Leaves are described as dielectric discs, for the broadleaf case, or dielectric needles, for the coniferous case. Branches and trunks are simulated as dielectric cylinders. The soil scattering is computed by using the Integral Equation Model. The overlying litter is described as a dielectric slab. Its permittivity is computed by means of the dielectric mixing formula, and multiple reflections at the boundaries are taken into account. The different contributions are combined by using an algorithm based on the radiative transfer theory. Global variables, such as woody biomass and Leaf Area Index, are used as input. Geometrical variables are derived by allometric equations and the permittivity values are derived by dielectric models available in the literature.

Results are shown in form of total emissivity and single contributions as a function of soil moisture and woody biomass. At the lower frequencies (e.g. L band), emission and scattering effects are mostly due to branches, but the contribution of soil is still appreciable, at least for mo derate biomass values. At the higher frequencies (e.g. C and X band), the importance of leaves increases, branch scattering tends to be more and more directed in the forward direction, and soil contribution is low.

Real cases of Mediterranean forests are considered. Model outputs are compared against multifrequency measurements carried out in Tuscany in 2000 and 2001 over various kinds of broadleaf forests, spanning a wide range of biomass values. Most of measurements were carried out in summer, but some samples collected in winter are also available. The model reproduces the increasing trend of emissivity as a function of frequency, as well as the increasing trend as a function of biomass, which is evident particularly at L band. For forests with moderate biomass, seasonal effects are observed in the experimental data, and are reproduced by simulations.

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