Recent studies about forest emission at L band, in view of SMOS

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In the framework of the SMOS Project, the Soil Moisture Prototype Processor Development (SMPPD) study is in progress, aimed at developing a soil moisture retrieval algorithm, The study adopts forward models which predict the emissivity of several land surfaces, at global scale, for a range of incidence angles useful for SMOS. For forests, five main categories, i.e. coniferous, deciduous broadleaf, evergreen broadleaf, mixed and woodland, have been identified. For each category, allometric equations available in the literature have been used to compute single tree variables as a function of trunk diameter at breast height (Dbh) (Jenkins et al., 2004), as well as Dbh distributions. Then, for each node of a world map, the ECOCLIMAP data base has been used to identify the forest category in that node and to extract the maximum yearly value of Leaf Area Index.
By using suitable routines, which will be described in the paper, distributions of geometrical and bio-physical variables influencing the forest emission process have been derived. In this way, for each node, an input data set for the discrete emission model has been generated.
In order to estimate the emissivity, the model developed at Tor Vergata University has been adopted. It is a discrete model, which represents forest elements as dielectric discs (broad leaves) or cylinders (trunks, branches, coniferous needles) of various dimensions. The permittivity is derived by the moisture, which is also estimated by literature information. The single contributions are then combined by using a matrix algorithm which considers multiple scattering effects. The model has been recently refined to include also litter effects. The litter has been modelled as a dielectric layer made by a mixture of dry vegetation and air. Multiple reflections at air-litter and litter-soil rough interfaces have been computed by means of a coherent model.

In order to test the model, results collected in recent campaigns have been used. During the second half of 2004, the “Bray-2004” experiment took place in Les Landes coniferous forest, in France. An L band radiometer was located on top of a tower, looking downward, in order to measure the brightness temperature of a mature coniferous stand. Radiometric measurements were multi-angular. Available ground truth includes all significant forest and soil variables. L band radiometric signatures were also collected during the autumn 2004 in the Research Centre Jülich (Germany). The ELBARA radiometer, operating at 1.4 GHz, was installed looking in the upward direction in a mixed hardwood forest. The average height of trees was about 20 meters, and the leaf fall process was monitored. Measurements with ELBARA allow distinguishing between the horizontal and the vertical polarisation, and the antenna beamwidth is 12 degrees. In November 2004, the ELBARA radiometer was located above the same forest, looking downward from a 100 m tower. The experiment was repeated after covering the soil with a metallic foil. Also the effects of artificial wetting were measured. Comparisons with Bray and Julich experiments allow us to test the model under several situations: coniferous and broadleaf forests, different soil conditions, downward and upward observations at several angles and two polarizations, soil coverage by a metallic sheet, etc.

This paper shows critical comparisons between model simulations and experimental data. Moreover, the results of a parametric investigation, aimed at estimating the effects of fundamental variables, such as soil moisture, forest biomass, observation angle, etc. are described. Both coniferous and deciduous forests are considered, at L band. Implications for soil moisture retrieval at global scale are presented and discussed