Geophysical Research Abstracts,
Vol. 11, EGU2009-3484, 2009
EGU General Assembly 2009

The effects of forest canopies and of the underlying soil moisture on microwave emission

S. Paloscia (1), S. Pettinato (1), E. Santi (1), P. Ferrazzoli (2), and R. Rahmoune (2)

(1) CNR-IFAC, Dept. of Earth Observation, Florence, Italy (s.paloscia@ifac.cnr.it, 00390555226434), (2) DISP, Univ. Tor Vergata, Rome, Italy (ferrazzoli@disp.uniroma2.it)

Forests are important interfaces between soil and atmosphere as they play a significant role in the water and gas exchanges (mainly O2 and CO2). Due to their capabilities in reducing evaporation from the surfaces and to intercept rainfalls, they are able to substantially modify the moisture behaviour of underneath soils. On the other hand, the moisture conditions of soils influence the evapotranspiration mechanisms and the emission and absorption of gases. The importance of retrieving information on forest and soil conditions is therefore extremely important for all the studies concerning global changes and CO2 balance.

The capability of microwave radiometers of penetrating inside vegetation covers, especially at the lower frequencies, is well known, but only few studies have investigated quantitatively the attenuation of soil emission under forests. In 2006, measurements were carried out in Tuscany by using a multi-frequency microwave radiometer (L, C, X, Ku and Ka bands) operating both in H and V polarizations, at incidence angles varying between 30° and 60°, and mounted on an hydraulic boom. The experiments were carried out in different seasons and therefore were characterized by various soil moisture and vegetation conditions. The obtained results pointed out that the influence of soil is clearly recognizable at L-band, at least for forest with moderate biomass and at steep incidence angles, whereas at the higher frequencies the changes in soil moisture basically do not influence microwave emission. Previous airborne measurements carried out over broadleaf forests with various biomass values indicated that, at L band, there is a general increasing trend of emissivity vs. biomass. It was also found that seasonal effects, related to variations of soil moisture and understory cover, produce appreciable effects at L band up to biomass values of about 200 m3/ha.

The results of both experiments have been compared against the outputs of a discrete electromagnetic model, which considers vegetation as an ensemble of disks and cylinders over a soil surface. The model is based on the radiative transfer theory and includes multiple scattering effects. Model inputs have been given on the basis of ground surveys over the same broadleaf forests. The model reproduces the increasing trend of emissivity as a function of frequency, as well as the increasing trend as a function of woody volume, which is particularly evident at L band. For forests with moderate woody volumes, also the seasonal effects, observed in the experimental data, are reproduced by simulations. Moreover, the trends of emissivity as a function of soil moisture are simulated for low biomass values. The trends are critically compared against measurements carried out in 2006. A general agreement is observed, and the differences are critically evaluated and interpreted.

A detailed analysis shows that crown emission dominates at all frequencies in case of high biomass, but is comparable with soil emission at L band and for moderate biomass. A parametric study indicates that the effect of forest geometry, for a given value of overall woody volume, is important. The emissivity of forests with higher values of dbh is considerably higher, for a given biomass. This effect, as well as the increasing trend of emissivity vs. frequency, is attributed to the higher values of the ratio between average branch diameter and wavelength.