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On the relationship between Active and Passive observations of vegetation: model and experiments

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1. Extended Abstract

In the past, studies concerning microwave remote sensing have been mostly separated between active and passive research. But lately, the joint use of the two observational techniques has been the subject of several investigations aiming at exploiting both the high spatial resolution of SAR systems and the good sensitivity to soil moisture characterizing the radiometric systems. Measurements collected by Aquarius, on board the SAC-D satellite, though planned for marine applications, have been employed to explore the possibility of a joint usage of active and passive land observation at L-band [1]. Furthermore, L-band SAR in orbit at present, such as ALOS, or planned for the future, such as SAOCOM, may be combined with L-band satellite radiometers. In this framework, many research studies were focused on the estimation of the β coefficient, the slope of a hypothetical linear relationship between emissivity and backscattering coefficient $\sigma°$, for different cover types, soil and vegetation parameters [2]. Soil and vegetation have different effects on emissivity and $\sigma°$ of land surfaces. In particular, for angles greater than 30° and for several plant cover, an increase of soil roughness or vegetation biomass determines an increase of both emissivity and backscattering. Whereas an increase of soil moisture produces opposite effects on the two electromagnetic measurements [3]. A physical interpretation of this finding is based on the relationship that links emissivity and $\sigma°$ to the bistatic scattering coefficient. Profiting from this formulation, in this work some simulations of emissivity and backscattering coefficient of bare soil, corn crops and forests have been performed for different soil moisture conditions. The model developed at the University of Rome Tor Vergata is based on this unified approach to calculate both emissivity and $\sigma°$ of the medium under study, that is through the bistatic scattering coefficient.
Theoretical results are compared with experimental data collected by means of different observation systems over various land cover. They are: data from SMAPEx (Soil Moisture Active and Passive Experiment) measured during eight airborne flights over the Gillenbah forest in New South Wales (Australia); data from SGP99 (Southern Great Plains), SMEX02 (Soil Moisture Experiment) and CLASIC (Cloud and Land Surface Interaction Campaign) collected over agricultural fields in the United States [4]; Aquarius data acquired globally at three days interval. Ground truths support the airborne campaigns, while satellite data have been interpreted with the aid of soil moisture and optical depth retrieved by SMOS (Soil Moisture and Ocean Salinity) L3 data. Both airborne and satellite data confirmed the active and passive theoretical simulations.
Finally the model has been used to predict the sensitivity of active and passive measurements to soil moisture under different vegetation conditions, and the β coefficient. The sensitivity of emissivity decreases monotonously with the vegetation amount, while the sensitivity of the backscattering coefficient does not show a definite trend because of the double bounce effect. The β coefficient is negative, showing a decreasing trend of its absolute value when the vegetation grows, and a higher absolute value at horizontal polarization

2. References

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