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Radar frequency effect on the relationship between surface soil moisture vertical profile and radar backscatter

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Soil moisture plays a key role in hydrological and climatic studies. Considerable efforts have been devoted to the study of radar backscattering responses from natural surfaces in active microwave remote sensing. Electromagnetic analytical backscattering models (Kirchhoff models, the small perturbation method, and more recently the Integral Equation Model (IEM,the AIEM, ...) have been used to estimate moisture parameter. However, various experimental measurements have shown that their use must be restricted to specific conditions. For studies in the L, C, and X frequency bands, empirical and semi-empirical models are often calibrated using soil samples collected down to a depth of five centimetres, in which the moisture content is assumed to be homogeneous. In recent years, some studies have revealed that using the actual, inhomogeneous soil moisture profile can make a significant difference in the results obtained from backscatter models. The aim of this paper is to discuss the influence of radar frequency on the relationship between surface soil moisture and the nature of radar backscatter over bare soils. In an attempt to answer this question, the Advanced Integral Equation Model (AIEM) was used to simulate backscatter from soil surfaces with various moisture vertical profiles, for three frequency bands: L, C and X. In these computations, we investigated the influence of the vertical heterogeneity of soil moisture on the characteristics of the backscattered signals. The influence of radar frequency is clearly demonstrated. A database produced from Envisat ASAR and TerraSAR-X data, acquired over bare soils with in situ measurements of moisture content and ground surface roughness, was used to validate the usefulness of taking the soil moisture heterogeneity into account in the backscattering model. These results confirm the significant influence of soil moisture heterogeneities on the strength of radar backscatter. It also highlights the sensitivity of inversion techniques and the dependence of the accuracy of retrieved soil moisture values on the moisture profile hypothesis and the radar frequency, with the latter being directly related to the penetration depth of radar waves.