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Modeling of the dielectric permittivity of porous soil media with water using statistical-physical models

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Radiometric observations with SMOS rely on the Radiation Transfer Equations (RTE) determining the Brightness Temperature (BT) in two linear polarization components (H, V) satisfying Fresnel principle of propagation in horizontally layered target media on the ground. RTE involve variables which bound the equations expressed in Electro-Magnetic (EM) terms of the intensity BT to the physical reality expressed by non-EM variables (Soil Moisture (SM), vegetation indexes, fractional coverage with many different properties, and the boundary conditions like optical thickness, layer definitions, roughness, etc.) bridging the EM domain to other physical aspects by means of the so called tau-omega methods. This method enables joining variety of different valuable models, including specific empirical estimation of physical properties in relation to the volumetric water content. The equations of RTE are in fact expressed by propagation, reflection and losses or attenuation existing on a considered propagation path. The electromagnetic propagation is expressed in the propagation constant. For target media on the ground the dielectric constant is a decisive part for effects of propagation. Therefore, despite of many various physical parameters involved, one must effectively and dominantly rely on the dielectric constant meant as a complex variable. The real part of the dielectric constant represents effect of apparent shortening the propagation path and the refraction, while the imaginary part is responsible for the attenuation or losses.

This work engages statistical-physical modeling of soil properties considering the media as a mixture of solid grains, and gas or liquid filling of pores and contact bridges between compounds treated statistically. The method of this modeling provides an opportunity of characterizing the porosity by general statistical means, and is applicable to various physical properties (thermal, electrical conductivity and dielectric properties) which depend on composition of compounds. The method was developed beyond the SMOS method, but they meet just in RTE, at the dielectric constant. The dielectric constant is observed or measured (retrieved) by SMOS, regardless other properties like the soil porosity and without a direct relation to thermal properties of soils. Relations between thermal properties of soil to the water content are very consistent. Therefore, we took a concept of introducing effects of the soil porosity, and thermal properties of soils into the representation of the dielectric constant in complex measures, and thus gaining new abilities for capturing effects of the porosity by the method of SMOS observations. Currently we are able presenting few effects of relations between thermal properties and the soil moisture content, on examples from wetlands Biebrza and Polesie in Poland, and only search for correlations between SM from SMOS to the moisture content known from the ground. The correlations are poor for SMOS L2 data processed with the version of retrievals using the model of Dobson (501), but we expect more correlation for the version using the model of Mironov (551). If the supposition is confirmed, then we may gain encouragement to employing the statistical-physical modeling of the dielectric constant and thermal properties for the purposes of using this model in RTE and tau-omega method. Treating the soil porosity for a target of research directly is not enough strongly motivated like the use of effects on SM observable in SMOS.