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Microwave brightness temperature and thermal inertia – towards synergistic method of high-resolution soil moisture retrieval

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Soil moisture is an important parameter in many environmental studies, as it influences the exchange of water and energy at the interface between the land surface and the atmosphere. Accurate assessment of the soil moisture spatial and temporal variations is crucial for numerous studies; starting from a small scale of single field, then catchment, mesoscale basin, ocean conglomeration, finally ending at the global water cycle. Despite numerous advantages, such as fine accuracy (undisturbed by clouds or daytime conditions) and good temporal resolution, passive microwave remote sensing of soil moisture, e.g. SMOS and SMAP, are not applicable to a small scale – simply because of too coarse spatial resolution. On the contrary, thermal infrared-based methods of soil moisture retrieval have a good spatial resolution, but are often disturbed by clouds and vegetation interferences or night effects. The methods that base on point measurements, collected in situ by monitoring stations or during field campaigns, are sometimes called "ground truth" and may serve as a reference for remote sensing, of course after some up-scaling and approximation procedures that are, unfortunately, potential source of error. Presented research concern attempt to synergistic approach that join two remote sensing methods: passive microwave and thermal infrared, supported by in situ measurements. Microwave brightness temperature of soil was measured by ELBARA, the radiometer at 1.4 GHz frequency, installed at 6 meters high tower at Bubnow test site in Poland. Thermal inertia around the tower was modelled using the statistical-physical model whose inputs were: soil physical properties, its water content, albedo and surface temperatures measured by an infrared pyrometer, directed at the same footprint as ELBARA. The results coming from this method were compared to in situ data obtained during several field campaigns and by the stationary agrometeorological stations. The approach seems to be reasonable, as both variables, brightness temperature and thermal inertia, strongly depend on soil moisture. Despite the fact that the presented research focused on modelling in the small size, 4 ha test site, the method is promising for larger scales as well, due to similarities between ELBARA and SMOS and between pyrometer and satellite imaging spectrometers (Landsat, Sentinel etc.). The approach will merge advantages: high accuracy of passive microwave sensing with a good spatial resolution of thermal infrared methods.

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