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EM simulations of a novel three-rod dielectric probe for measurements of soil moisture gradient

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Measurement of soil moisture gradient can be used in soil-water fluxe studies. The investigation of such processes needs a probe which registers temporal changes of soil-moisture spatial distribution. Determining soil moisture gradient requires the use of several TDR probes or a profile probe in a form of a long tube with several sensing elements placed at various distances along the tube. The aim of our research is to develop a novel single TDR probe with the capability of registering soil moisture gradients.
The designed probe is equipped with three parallel rods mounted in the corners of an equilateral triangle. The TDR measurements are performed sequentially in three steps. In each step one of the rods works as a signal electrode, while the remaining two rods are grounded. The configuration of the signal rod and the grounded rods changes with each measurement step. In this way, the probe allows to measure the dielectric permittivity spatial distribution between and around the rods, which corresponds to soil moisture distribution.
This work presents a numerical model and analysis of the three-rod TDR probe for soil moisture gradient measurements. The electromagnetic simulations were used to study the influence of the probe geometry on the sensitivity and resolution of the probe with respect to measured material heterogeneity. The obtained simulations results allow to optimize the design and shape of the sensitivity zone of the three-rod probe.
The future work will include constructing the sensor. Laboratory tests will also be conducted and measurements data will be compared with simulation data. Also, field measurements will be conducted to determine soil moisture gradients in field conditions.

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