Geophysical Research Abstracts
Vol. 21, EGU2019-13796-1, 2019
EGU General Assembly 2019

Influence of soil moisture, salinity and texture on broadband complex dielectric permittivity spectra

Agnieszka Szypłowska (1), Arkadiusz Lewandowski (1,2), Justyna Szerement (1), Marcin Kafarski (1,3), and Andrzej Wilczek (1)

(1) Institute of Agrophysics, Polish Academy of Sciences, Lublin, Poland (a.szyplowska@ipan.lublin.pl), (2) Institute of Electronic Systems, Warsaw University of Technology, Warsaw, Poland (a.lewandowski@elka.pw.edu.pl), (3) The State School of Higher Education in Chełm, Chełm, Poland (m.kafarski@ipan.lublin.pl)

Soil dielectric properties are heavily influenced by the water content, hence many soil moisture sensors measure dielectric permittivity, either in the time domain (TDR devices) or in the frequency domain (FDR devices). TDR instruments measure bulk dielectric permittivity, which is a quantity averaged over the applied electrical pulse spectrum, additionally filtered by the soil under test. The impact of soil salinity and texture is not high for most mineral soils. On the other hand, FDR devices measure dielectric permittivity at a certain frequency, usually not higher than 100 MHz. The advantage of FDR devices is a competitive price with respect to TDR instruments. However, in this frequency range, in addition to soil moisture, also soil salinity and texture significantly influence dielectric permittivity, which decreases the selectivity of moisture measurement. Thus, in order to increase the measurement accuracy, soil-specific calibration is usually recommended by sensors manufacturers. There are also ongoing efforts to develop a broadband FDR sensor that would enable accurate and selective moisture measurement while remaining cost-efficient. The knowledge of the impact of soil salinity and texture on complex dielectric permittivity in a broad frequency range is highly beneficial for the purpose of assessment and comparison of existing sensors, as well as for the development of new instruments.

The aim of the work was to examine the impact of soil salinity and texture on complex dielectric permittivity spectra of samples of 14 soils of various texture in the 20 MHz – 3 GHz frequency range. Soil dielectric permittivity spectra were measured with the use of a coaxial transmission-line cell connected to a vector-network-analyzer. The obtained spectra were modeled with the use of a three-pole Debye model with DC electrical conductivity term. The determined dielectric relaxation parameters were correlated with soil salinity and texture parameters. Next, an optimal soil moisture determination procedure based on dielectric parameters was proposed. The use of broadband spectra modeling enabled high selectivity with respect to salinity and texture while minimizing the impact of measurement errors at specific frequencies.

The project is financed by the Polish National Agency for Academic Exchange.