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Coupling between dielectric relaxation behaviour and hydraulic material properties of subsoil

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High frequency electromagnetic determination of moisture in porous media (e.g. soil), is based on the strong relationship between volumetric water content and relative dielectric permittivity. In particular, in fine-grained soils the movement of water is influenced by different surface bonding forces due to interface processes. The interface effects lead to a number of dielectric relaxation processes (free and bound water phase, Maxwell-Wagner-effect, counterion relaxation effects).These relaxation processes are the reason for the strong frequency dependence of the electromagnetic material properties below 1 GHz. The matric potential is a measure of the bonding forces on water in the soil. Hilhorst et al. 2001 (Soil Sci Soc Am J, 65(2):311 - 314) suggested a thermodynamic approach for the relationship between soil matric potential and dielectric relaxation behavior of water in different binding states. Based on this approach a broadband dielectric relaxation model was developed which considers low frequency dispersion up to 1 MHz as well as losses due to direct current conductivity. The sensitivity of the model on soil suction was systematically analyzed based on a pedotransfer function (PTF) given by Carsel and Parrish 1988 (Water Res. Res., 24:755 - 769) for soil textures ranging from pure sand up to pure clay. The results are compared with known empirical and semiempirical calibration functions, as well as theoretical mixing models.

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Contribution

Title:	Coupling between dielectric relaxation behaviour and hydraulic material properties of subsoil
Presentation type:	Poster
Session	UI Environmental- and Engineer-Geophysics
Keywords:	
Key Topic(s):	S 2 Geophysics in archaeology and Soil Science
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Special devices:	