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Effect of soil moisture on detection of soil organic horizon boundary using Ground penetrating radar (GPR)

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Ground penetrating radar can be a helpful tool in soil studies. Numerous ecological and biogeochemical studies require an estimation of soil organic horizons thicknesses, because soils are important pool of nutrients such as carbon and nitrogen and a large portion of it is stored in the organic horizon. Due to high spatial variability of its thickness the best possible estimation is important and needed. Application of the GPR was proved promising by several studies; however its successful application depends on several factors such as soil moisture. We studied the effect of soil moisture on detection of soil organic horizon boundary.

Our measurements were performed using 800 MHz antenna on two soil types: Cambisol in a sub-montainous Spruce forest and Podzol in thin Pine forest. The same transects were surveyed repeatedly under different soil moisture conditions. The studied Podzol developed over tertiary sandstones and the surveyed transect followed the top of an old sand pit wall. The surveyed transect in Cambisol was partly uncovered by a trench excavated after the measurements. Thus, we were able to document soil horizon boundaries, bigger stones, and roots and compare the GPR radargrams with described profiles. At the same time, the soil dielectric permittivity was measured using a TDR probe for electromagnetic signal velocity assessment.

The results show that GPR outputs are clearer under very dry conditions at both localities. The organic horizons were dry with almost no moisture and very low dielectric permittivity, while even low content of water in the underlying mineral horizons increases their dielectric permittivity making the boundary clearer. However, in Cambisol, in a spruce forest, the clarity of the radargram showing horizon boundaries is disrupted by tree roots uptaking water from lower depths. In the Podzol with almost no tree roots and stones, there is evident even a spodic Bhs horizon. The surveyed Arenic Podzol is not much texturally differentiated, so that the ferromagnetic content or the compaction of Bhs could be detected. In the Cambisol, higher moisture makes only the organic horizons to slightly increase dielectric permittivity. The precipitation should be hard enough to penetrate through whole soil profile and create a medium consisting of organic horizons with lower dielectric permittivity than underlying mineral horizons after the precipitation.