Detecting soil compaction with a ground penetrating radar

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Soil compaction adversely affects biological properties and functions of the soil leading to substantial crop productivity losses. Typically, soil compaction is measured using manual soil probes that provide single-point data resulting in hundreds of manual measurements needed to map an entire field. A ground penetrating radar (GPR) system measures the dielectric permittivity of the soil at a high frequency as it is pushed over the soil. This potentially offers an opportunity to develop detailed soil compaction maps even for large fields. We tested the ability of a ground-coupled antenna GPR to measure soil compaction. The GPR signal intensity was lower for compacted soil than for non-compacted soil when the GPR was in permanent contact with the soil during measurements. However, significant sources of error were identified that resulted in signal intensities strong enough to confound the measurements of soil compaction. Most notably, a small air gap of 3 to 5 cm between the soil and the GPR resulted in a stronger signal than the signal obtained from soil compaction. Similarly, plant residues also resulted in stronger signals than the signal obtained from soil compaction. Since uneven soil surfaces and plant residues are expected in any agricultural field, an approach that does not require the GPR to be ground-coupled and that can differentiate plants from soil is needed.