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Field-based geophysical characterization of soil structure

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Soil structure exerts a significant influence on key soil hydrological, agricultural and ecological functions. Moreover, soil structure varies temporally and spatially in response to biological, anthropogenic and climatic perturbations. Soil structure variability often occurs at the pore scale, but may induce important variability in soil functioning at much larger scales (e.g., plot, field, catchment). Advancing our understanding about the feedbacks between soil structure and its drivers and, thus, enabling sustainable strategies for soil management in agricultural and ecological contexts, partly relies on the systematic quantification of soil structure and its variations across temporal and spatial scales. However, in-situ characterization of soil structure at these larger scales is challenging, and impractical when using traditional characterization techniques (e.g., soil sampling). Geophysical methods may contribute with observation capabilities at these larger scales. One promising approach puts emphasis on transport processes (e.g., fluid and heat flow) that are governed by soil structure and targets the indirect inference of soil structural elements throughout a framework in which in-situ time-lapse measurements are used to infer system properties. Minimally invasive geophysical methods are capable of monitoring the processes of interest, yet the development of strategies for data integration and modeling remains challenging. In this work, we present the signatures observed from different soil structures on time-lapse DC-resistivity monitoring data from a controlled field experiment in the vicinity of Zürich, Switzerland, and discuss ways to integrate these observations within a coupled hydrogeophysical modeling framework designed for soil structure inference. The time-lapse DC-resistivity data, collected over a four-month period starting in the Spring of 2018, identifies clear signatures of soil structure (e.g., rates of drainage) for soils with different treatments and covers (combinations of compacted and uncompacted, vegetated and unvegetated soils). Additionally, we present preliminary results showing the fingerprint of soil structure on (time-lapse) seismic data collected at the same experimental field.