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Non-invasive monitoring of flow and transport processes with MERIT

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The non-invasive measurement of physical parameters in undisturbed soil samples is an important tool for observation and sustainable management of soils and aquifers so as to preserve or to restore groundwater quantity and quality from natural or anthropogeneous effects. Therefore, a spatially and temporally highly resolved monitoring and characterization of soils and aquifers is often required. A broad range of mechanistic models that predict water flow and solute transport in the subsurface environment is currently available. However, to use and validate these models a proper set of data must be collected, preferrably without disturbing the soil and aquifer system.

We present Magneto-Electrical Resistivity Imaging Technique (MERIT) to monitor fluid flow and solute transport processes. We computed several synthetical data sets of electric potential and magnetic fields for a cylindrical soil column due to a constant excitation current. The internal electrical conductivity of the column was varied by a) a modeled water infiltration process into a dry sandy soil column and b) an assumed solute transport process of a tracer plume with a by factor 2 lower electrical conductivity. The results of the numerical experiments lead to the technical specifications of the MERIT scanner hardware to monitor the assumed processes adequately.

Exemplary the synthetic data set of the tracer transport experiment was further processed. We used a 3D inversion algorithm to reconstruct the electrical conductivity distribution from the data at different time steps. The inversion results we obtain from the data show a good comparison to the temporal and spatial distribution assumed in the modeling. Especially the center of gravity of the tracer plume is exactly estimated by the inversion, while the geometrical spread estimation has to be improved.