INVITED ORAL PRESENTATION
Session: Advances in Monitoring and Time-Lapse Imaging of Subsurface Processes

Coupled hydrogeophysical inversion of time-lapse geophysical data

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Coupled hydrogeophysical inversion aims to improve the use of time-lapse geophysical data for hydrological model parameterization. Numerical studies have firmly established the feasibility and advantages of a coupled approach, and the number of studies that apply this approach to actual data is steadily increasing. In this invited contribution, we will present an overview of our recent developments in coupled hydrogeophysical inversion, and address current challenges. In particular, coupled inversion frameworks were developed for the estimation of effective soil hydraulic properties from time-lapse electrical resistivity tomography, time domain reflectometry, and streaming potential measurements. The soil hydraulic property estimates obtained with coupled inversion compared favourably with independent reference values in all our case studies, thus confirming the power of coupled hydrogeophysical inversion. A prerequisite for coupled inversion is a good description of the hydrological processes that determine the time-lapse changes in the geophysical monitoring data. In case of considerable model structural uncertainty, the advantage of the coupled inversion is reduced and alternative interpretation methods might be more appropriate. A Bayesian formulation of coupled inversion was also developed, and it was found to be useful to assess the posterior uncertainty of the estimated model parameters and the model predictions. This kind of information is of great value and can be used to analyze the worth of different experimental data sources and for experimental design questions (e.g. optimization of amount and timing of measurements). Finally, coupled inversion was established as a natural framework for the fusion of multiple types of geophysical and hydrological data. However, the trade-offs between fitting different data types need to be carefully considered for hydrological interpretation. The remaining challenges are mainly associated with the computational burden associated with coupled hydrogeophysical inversion frameworks, in particular when using a Bayesian approach in combination with three-dimensional hydrological and geophysical models.