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Improved site contamination through time-lapse complex resistivity imaging

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In the framework of the EU FP7 project ModelPROBE, time-lapse complex resistivity (CR) measurements were conducted at a test site close to Trecate (NW Italy). The objective was to investigate the capabilities of the CR imaging method to delineate the geometry and dynamics of subsurface hydrocarbon contaminant plume which resulted from a crude oil spill in 1994. To achieve this it is required to discriminate the electrical signal associated to static (i.e. lithology) from dynamic changes in the subsurface, with the latter associated to significant seasonal groundwater fluctuations. Previous studies have demonstrated the benefits of the CR method to gain information which is not accessible with common electrical resistivity tomography. However field applications are still rarely and neither the analysis of the data error for CR time-lapse measurements, nor the inversion itself haven not received enough attention. While the ultimate objective at the site is to characterize, here we address the discrimination of the lithological and hydrological controls on the IP response by considering data collected in an uncontaminated area of the site. In this study we demonstrate that an adequate error description of CR measurements provides images free of artifacts and quantitative superior than previous approaches. Based on this approach, differential images computed for time-lapse data exhibited anomalies well correlated with spatiotemporal changes correlated to seasonal fluctuations in the groundwater level. The proposed analysis may be useful in the characterization of fate and transport of hydrocarbon contaminants relevant for the site, which presents areas contaminated with crude oil.