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Joint hydrogeological and hydrogeophysical models to map subsurface heterogeneity and to model transport processes

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Hydraulic conductivity and electrical resistivity of the alluvial sediments depend, among the others, on textures and soil saturation. Characterization of the subsurface heterogeneity and monitoring the dynamics of groundwater can be accomplished by the collection of geoelectrical and hydraulic data and by the joint modeling of the corresponding physical processes. A research project, during which it has been developing an interpretative tool that profits from DC geoelectrical and hydraulic measurements, aims to provide a further step towards this objective. Two original computer codes, both based on conservative finite differences schemes, have been developed to solve the hydrological (YAGMOD) and the geoelectrical (YAELMOD) forward problems. The subsurface is considered to be subdivided in hydro-geo-bodies, which are regions occupied by geological materials (hydro-geo-facies, HGF) which share the same geoelectrical and hydrodynamic characteristics, namely phenomenological laws that relate electrical resistivity and hydraulic conductivity to texture, soil saturation and pore water conductivity, through specific phenomenological parameters for each HGF. If the spatial distribution of HGFs is estimated from a collection of lithological data (e.g. boreholes) and if the spatial distribution of soil saturation and pore water conductivity is known, then the hydraulic conductivity and electrical resistivity fields could be reconstructed. The developed interpretative tool could then apply an iterative procedure that repeatedly solves the hydraulic and electrical forward problem for different stress condition of the aquifer by changing the estimated HGF parameters, as a basic step to match experimental data with model outcomes, by the application of an approach based on the Kalman filter. In particular the goal of this presentation is to assess the sensitivity of some of the model features on the results and on the capability of the interpretative tool. The focus is on a thorough sensitivity analysis of the effect that the boundary conditions have on the model results and of the resolution of the phenomenological HGF parameters. This is a key issue, because the application of the developed tool will rarely be done for sites which reach the physical boundaries of the system and therefore different kinds of somehow arbitrary boundary conditions will be usually required.