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Groundwater parameter inversion using an adaptive multiscale procedure: case study and boundary condition sensitivity analysis

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The identification of aquifer parameter (i.e. storativity and hydraulic conductivity) is crucial for the process of modeling groundwater flow and contamination. Inversion techniques allow to unravel complex systems heterogeneity, computing parameter fields through an automated minimisation between simulated and measured data (i.e. water head or aquifer parameter).

This study uses an Adaptive Multiscale Triangulation (AMT), which dissociates the parameter grid from the calculation mesh and refines it under zonal minimisation criteria, shortening the computation time while ensuring flexibility in regard to the parameter distribution. Groundwater flow is described by a nonlinear diffusion-type equation, discretised with a 2D nonconforming finite element method, water head data not being suitable to invert 3D parameter fields. Therefore, only the horizontal component of flow is considered while the parameters are obtained as average values on the aquifer thickness.

The study area is a single layer alluvial (unconfined) aquifer of 7.6 km^2, situated in the southern, Mediterranean part of France. The inversion run with a chronicle of 45 piezometers over 5 years (2012-2017). Best converging simulations show few discrepancies between calculated and observation values (e.g.):
mean error 0.07 – 0.22 – 0.82 / error standard deviation 0.01 – 0.15 – 0.25 [min – average – max of 45 chronicles, in meters].

Good matching is reached in spite of great uncertainties regarding the northern boundary conditions of the model. The few chronicles available in this area only allow to infer the occurrence and the global dynamics of a transient incoming water flux from the overflow of a neighbouring limestone aquifer. But in the absence of monitoring equipment in the latter, the magnitude of this inflow is estimated iteratively “by hand” on the basis of the inversion results (minimisation objective function final values and computed parameter fields). Once settled on a range of probable values, a sensitivity analysis to this inflow is carried out, in order to determine the relevance and the location of supplementary piezometers.

Furthermore, the inverted values are destinated to constrain a geostatistical procedure generating 3D parameter fields, which are required to run contamination models.