Physical-based Stochastic Inversion Assessing Aquifer Parameter and Boundary Condition Uncertainty

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Abstract. The scope of this paper is to evaluate the uncertainty of a new physical-based inverse method for aquifer flow inversion. The accuracy of inversion is evaluated against (a) heterogeneity representation and resolution of the inverse problem, (b) observation data quality, and (c) data quantity. Three inverse grids, the SIS grid, a Simulated Annealing (SA) grid with smoothed facies distribution, and a coarsened gird, were first inverted using the same error-free data from 12 wells. Conductivities were estimated with a precision of ±7% (SIS), ±12% (SA), ±10% (coarsened) of their true values, respectively. Compared to the true values, the distributions of Ks also exhibit increasing biases: 0.5% (SIS), 1% (SA), 5% (coarsened). In terms of BC recovery, the uncertainty region was within ± 2.5% (SIS), ±2% (SA), and ±1% (coarsened) of the true BC. Next, inverse problems were solved using observed hydraulic heads corrupted by increasingly higher errors (0, ±2%, ±5% of the total head variation). The resulting uncertainty in K estimations was ±10% (0), ±14% (2%), and ±16% (5%), respectively. The uncertainty of the estimated BCs was ± 2.5% (0), ± 3% (2%) and ±5% (5%). Finally, using both static and dynamic (error-free) data sampled from a decreasing number of wells (12, 6, 3), SIS-based facies simulation was carried out and inverted with decreasing data support. The computed Ks were spread over an uncertainty region of ±10% (12), ±25% (6), ±50% (3), while the accuracy of the recovered BC was within ± 2.5% (12), ±5% (6), and ±10% (3).