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# A parsimonious model explains mass distribution in the first MADE experiment

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The MAcroDispersion Experiment (MADE) conducted in the 80s in the highly heterogeneous aquifer at the Columbus Air Force Base near Columbus, Mississippi, inspired a wealth of research dealing with transport in highly heterogeneous porous media. Besides the initial effort in characterising the aquifer and in conducting and monitoring tracer tests, additional activities have been conducted to improve the model of spatial variability, by means of DPIL measurements. To date MADE is a widely recognised as a reference experimental site for testing and validating new modelling approaches in highly heterogeneous formations, and it has been widely used to validate stochastic modelling. In the present work we investigate the reciprocal role of the model of spatial variability and the representation of tracer injection in reproducing the distribution of the tracer mass at all the available snapshots. Simulations are performed by using information on the aquifer's properties extracted from the first characterisation of the site, which are in line with what is commonly done in contaminated sites, without resorting to calibration. In particular, we investigated the predictive capability of a minimalistic model of spatial variability, which uses only information from a preliminary granulometric analysis performed during the early characterization of the site, without resorting to the recent DPIL measurements. The effect of simplifying assumptions on the injection mode was also investigated. Heterogeneity is modelled by generating realisations of the spatial arrangement of two materials, epitomising the distribution of a possible aggregation of hydrogeological facies into two classes: coarse and fine. The Monte Carlo realisations are conditional to observations in the boreholes and a constant (homogeneous) hydraulic is assigned to the each material. The spatial distribution of material properties is generated by the transition probability method implemented in the TPROGS code, flow is solved by Modflow and transport by particle tracking. We conclude that the proposed model is able to reproduce the bulk of the plume despite the relatively small amount of information used to reproduce the hydraulic property variations, but that high uncertainty remains in the representation of the fast moving portion of the plume. However, this uncertainty is unavoidable and rather independent from the model of spatial variability because chiefly due to incomplete mass recovery, which is significant despite the high density of the monitoring system. This confirms the inadequacy of traditional monitoring systems in detecting fast moving components and a plume and calls for new monitoring approaches.