ORAL PRESENTATION - 48TH IAH CONGRESS (2021): "INSPIRING GROUNDWATER"

ABSTRACT ID 53

FOR SESSION 14: *Advances in forward and inverse groundwater modeling and open source tools for computational subsurface hydrology (uncertainty)*

THE POTENTIAL OF A MONTE CARLO BASED SENSITIVITY ANALYSIS FOR TRANSPORT USING A HEAT-SOLUTE TRACER TEST IN ALLUVIAL SEDIMENTS

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For numerical aquifer modeling with uncertainty quantification, a sensitivity analysis is a mandatory process. One-factor-at-a-time procedures, i.e., changing one, calibrated input parameter and keeping the other fixed, are still very popular for hydrogeologists. This show immediately which input parameters have the most influence on the results, but the simultaneous variation of multiple input parameters cannot be taken into consideration. This avoids the detection of interactions between input parameters and makes this procedure uncertain. A sensitivity analysis must quantify the relationship between input and model response uncertainty.

Thus, a Monte Carlo based sensitivity analysis as a distance-based global sensitivity analysis (DGSA), is here performed. This new kind of sensitivity analysis can reveal key information about parameters most influencing the model outcomes. In this study, the basis for DGSA are 250 Monte Carlo realizations, sampled from a prior distribution that was not previously rejected (i.e., falsified) considering a joint heat-solute tracer experiment in alluvial sediments. In other words, several sets of randomly chosen model parameters were tested for their consistency with the observed data (i.e., prior falsification). In DGSA, the distance between model outcomes is calculated and projected in a low dimensional space. Simulations with a comparable distance to the reference data are a cluster. The parameter cumulative distribution function within k clusters is compared to the reference distribution to deduce the sensitivity. DGSA analyzes both, global parameters (Mean hydraulic conductivity, porosity, etc.) and local high dimensional parameters characterizing the spatial heterogeneity like the complex hydraulic conductivity field generated with sequential Gaussian simulation in the prior. The latter are considered through their principal components replacing multiple statistical parameters with a limited, smaller, and approximated amount of linear combinations.

The results show that the heat tracer seems to be less sensitive to global advective parameters like porosity, indicating the complementary tracer behavior. The principal components describing local spatial heterogeneity are sensitive for the heat and the solute tracer, but heat tends to remain more dominated by conduction. Thus, for robust transport decisions using any stochastic Bayesian inversion, an adequate prior description in conjunction with a global sensitivity analysis considering uncertainty is a prerequisite.

References

- Dassargues A., 2018. *Hydrogeology: groundwater science and engineering*. Taylor & Francis CRC press, Boca Raton.
- Hermans T., Wildemeersch S., Jamin P., Orban P., Brouyère S., Dassargues A. and Nguyen F., 2015, Quantitative temperature monitoring of a heat tracing experiment using cross-borehole ERT, *Geothermics* 53: 14-26
- Hermans Th., Nguyen F., Klepikova M., Dassargues A. and J. Caers, 2018. Uncertainty quantification of medium-term heat storage from short-term geophysical experiments, *Water Resources Research*, 54: 2931-2948.
- Hoffmann R., Dassargues A., Goderniaux P. and Th. Hermans, 2019. Heterogeneity and prior uncertainty investigation using a joint heat and solute tracer experiment in alluvial sediments. *Frontiers in Earth Science*, 7: 10.3389/feart.2019.00108
- Klepikova M., Wildemeersch S., Jamin P., Orban Ph., Hermans T., Nguyen F., Brouyere S. and Dassargues A., 2016, Heat tracer test in an alluvial aquifer: field experiment and inverse modelling, *Journal of Hydrology* 540: 812-823.
- Wildemeersch S., Jamin P., Orban Ph., Hermans T., Klepikova M., Nguyen F., Brouyère S. & Dassargues A., 2014, Coupling heat and chemical tracer experiments for estimating heat transfer parameters in shallow alluvial aquifers, *Journal of Contaminant Hydrology* 169: 90-99.