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The Use of Iterative Ensemble Smoother in Data Assimilation and Predictive Uncertainty

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Summary

A deterministic groundwater numerical model is believed to be the most accurate representation of the conceptual site model expert knowledge that can match historical observations of the groundwater flow system. Although, natural subsurface materials should be expected to be spatially variable and have different properties at different scales. Numerical models are inevitably simplified representations of natural heterogeneous systems. The cost of simplification can be a valid assumption, depending on the primary objective for building a numerical model. In some situations, model simplifications may lead on bias in the model predictions (White et al. 2019). In those situations, heterogeneous parameter fields for specific hydrogeological units are required to avoid bias in the model predictions. One of the challenges associated with heterogeneous parameter fields, is the computational burden associated to the increased number of adjustable parameters through the inversion process. Computational burden is further added, when instead of using a deterministic solution, stochastic simulations are used to generate several equiprobable realizations of parameter sets, referred herein as ensemble stochastic simulations, as the basis for data assimilation and/or predictive uncertainty evaluation. Fortunately, work from Emerick and Reynolds (2013) and Chen and Oliver (2013) allowed for the reformulation of the Gauss-Levenberg-Marquardt (GLM) iterative Ensemble Smoother (iES) to approximate the Jacobian matrix of the inverse problem and drastically change modeler's ability to efficiently assimilate data to ensemble of stochastic simulations. The algorithm developed by Chen and Oliver (2013) was recently implemented in PESTPP-iES (White, Welter and Doherty 2019) and this presentation will present a case study using PESTPP-iES. The performance and challenges of using PESTPP-iES over traditional deterministic parameter optimization will be discussed.

References

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