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Prior ensemble based on geomechanical far-field approximations for data assimilation with ES-MDA in naturally fractured reservoirs

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The reservoir rock in subsurface applications such as geothermal or hydrocarbon reservoirs, geological carbon sequestration or nuclear waste deposition is often fractured. When fractures are present, they can potentially dominate flow and transport in those applications. It is therefore necessary to characterize the relevant fracture parameters, particularly the fracture apertures, as good as possible to reliably predict performance and assess risks. However, direct measurement of fracture parameters is difficult. Usually, only data from sparsely located wells and seismic measurements is available. Therefore, indirect methods such as outcrop analogues, geological models and production data become crucial.

Ensemble-based data assimilation is a widely used technique in subsurface applications to match production history, reduce uncertainties in model parameters and improve simulation results. In this work, we use the ensemble smoother with multiple data assimilation (ES-MDA) (Emerick & Reynolds, 2013). As an iterative ensemble smoother, ES-MDA is suited for (at least weakly) nonlinear systems (Evensen, 2018) and various studies have successfully applied it for reservoir characterization (e.g. Emerick, 2016; Ranazzi & Sampaio 2019; Todaro et al., 2021).

In this study, we use a 2D fracture geometry with more than 3500 individual fractures obtained from aerial photographs of an outcrop (Odling, 1997). We therefore assume that the fracture geometry is known a priori except for the fracture apertures. In our model, each fracture has a different aperture which is constant over the fracture length. We consider a scenario where all fractures have an initial fracture aperture which is a function of the fracture roughness. We then apply a constant far field stress, such that fractures open due to shear dilation and close due to normal stress. The exact fracture apertures are however unknown due to uncertain model parameters (e.g. fracture roughness or rock properties).

We use ES-MDA based on flow and transport data to reduce the uncertainties regarding fracture apertures and study the influence of the prior ensemble on the performance of the data assimilation framework. Calculating the individual realisations of the prior ensemble with a geomechanical simulator is expensive. A purely stochastic approach on the other hand does not incorporate all geological knowledge. As a compromise between those two methods, we propose to generate the prior ensemble based on geomechanical far field approximations which do not rely on geomechanical simulations, while geological knowledge still is incorporated to some degree. Compared to the purely stochastic approach we expect that the required number of realisations is smaller, if such a prior ensemble is employed, since it tends to be closer to the reference.

Participation

In-Person

References

EMERICK, A. A. & REYNOLDS, A. C. 2013. Ensemble smoother with multiple data assimilation. Computers & Geosciences. DOI: https://doi.org/10.1016/j.cageo.2012.03.011

EMERICK, A. A. 2016. Analysis of the performance of ensemble-based assimilation of production and seismic data. Journal of Petroleum Science and Engineering. DOI: https://doi.org/10.1016/j.petrol.2016.01.029

EVENSEN, G. 2018. Analysis of iterative ensemble smoothers for solving inverse problems. Computational Geosciences. DOI: https://doi.org/10.1007/s10596-018-9731-y

ODLING, N. E. 1997. Scaling and connectivity of joint systems in sandstones from western Norway. Journal of Structural Geology. DOI: https://doi.org/10.1016/S0191-8141(97)00041-2

RANAZZI, P. H. & SAMPAIO, M. A. 2019. Ensemble size investigation in adaptive ES-MDA reservoir history matching. Journal of the Brazilian Society of Mechanical Sciences and Engineering. DOI: https://doi.org/10.1007/s40430-019-1935-0

TODARO, V., D'ORIA, M., TANDA, M. G. & GÓMEZ-HERNÁNDEZ, J. J. 2021. Ensemble smoother with multiple data assimilation to simultaneously estimate the source location and the release history of a contaminant spill in an aquifer. Journal of Hydrology. DOI: https://doi.org/10.1016/j.jhydrol.2021.126215

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