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Uncertainty Quantification of Multi-Phase Porous Media Flows on GPUs

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Project Overview

- In monitoring subsurface aquifer contamination, we want to predict quantities using subsurface fluid flow models with expertise and limited data.
- In a Bayesian framework we use an MCMC algorithm for the characterization of subsurface properties, which is used in the contaminant flow (single-phase) model for the prediction of the contaminant concentration.
- The MCMC algorithm is serial in nature and thus computationally costly for practical applications. A drastic reduction in computing cost is achieved by running several MCMC chains.
- However, a careful study of the convergence of several MCMCs is required for a reliable characterization.

Best Practices/Successes

- In this work we first propose a fitting procedure for the Multivariate Potential Scale Reduction Factor (MPSRF) data that allows us to estimate the number of iterations required for convergence.
- An analysis of ensembles of fractional flow curves suggests that the number of iterations required for convergence through the MPSRF analysis is excessive.
- Thus, for practical applications, our results provide an indication that an analysis of the posterior distributions of quantities of interest provides a reliable criterion to terminate MCMC simulations for quantifying uncertainty.

Conclusion

- With a proper convergence analysis, parallel shorter MCMCs are reliable for subsurface characterization and prediction of porous media flows [1].

[1] A. Al-Mamun, J. Barber, V. Ginting, F. Pereira, **A. Rahunanthan**, Contaminant transport forecasting in the subsurface using a Bayesian framework, Applied Mathematics and Computation, Volume 387, 2020,124980, https://doi.org/10.1016/j.amc.2019.124980.