Probabilistic Sensitivity Analysis for Final Repository PA Models

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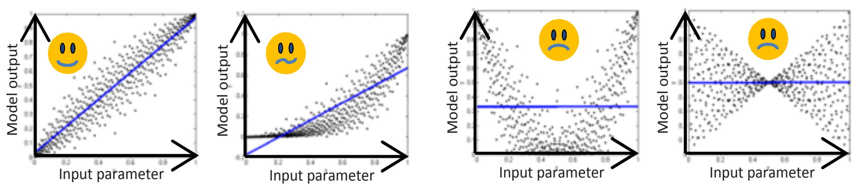
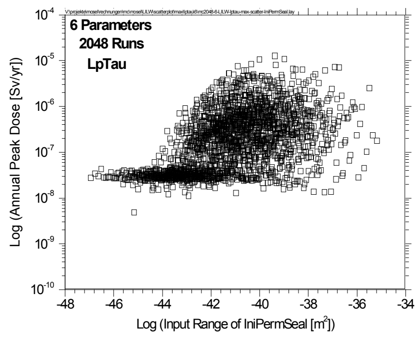
The problem

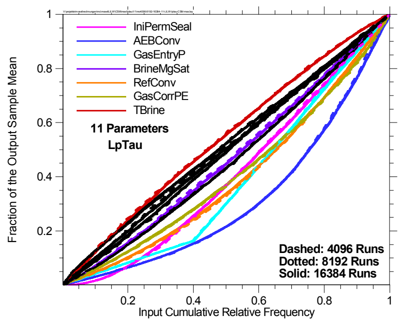
Performance Assessment (PA) models for final repository systems include many coupled effects and can show non-linear, non-monotonic or even non-continuous behaviour. Classical (linear regression / correlation) methods of probabilistic sensitivity analysis (SA) may fail or yield misleading results if applied to such models.



What can be done?

- ***Rank transformation*** can improve the robustness of results of linear SA methods for monotonic models for the price of losing information.
- ***Variance-based*** SA methods can quantify non-monotonic functional input-output dependencies.
- ***Graphical*** SA methods give an optical impression of the system sensitivity.





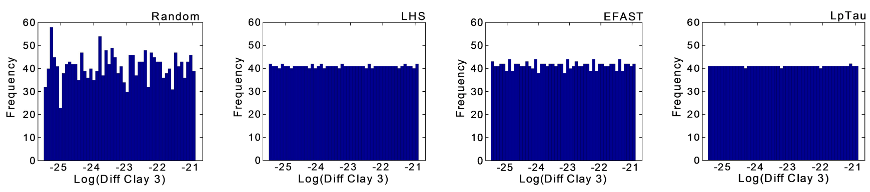
- ***Other methods*** can provide additional information (density-based evaluation, non-parametric regression, non-parametric sensitivity tests, ...)

Recent and current projects

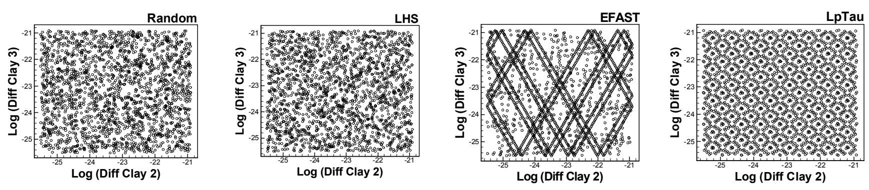
- PAMINA (EU): Testing and benchmarking of SA methods on the basis of simple mathematical models and realistic models
- NUMSA (TU-C): Deriving an adaptive and stepwise approach to SA
- MOSEL (GRS): Assessing the applicability of SA methods and sampling schemes to realistic repository PA models

Sampling methods

- Parameter range coverage (sample size 2000):



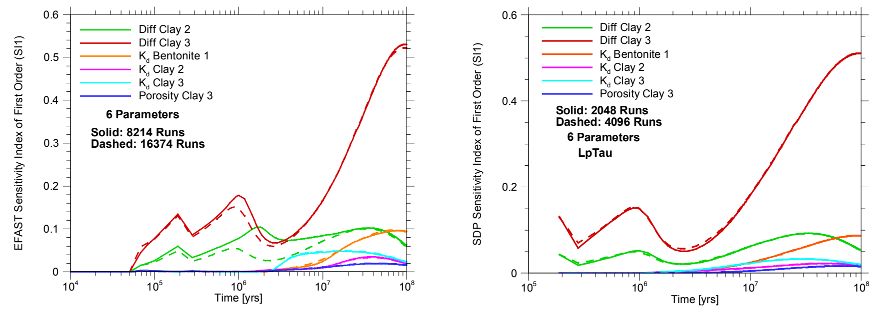
- Distribution of points in parameter space:



Model A: Repository for HLW in a clay formation

Relatively smooth model behaviour

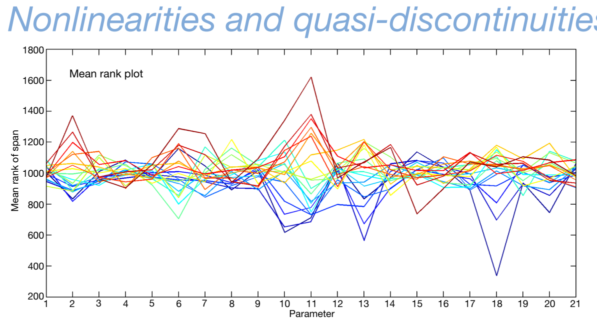
Comparison of EFAST sampling and evaluation with LpTau sampling/SDP evaluation

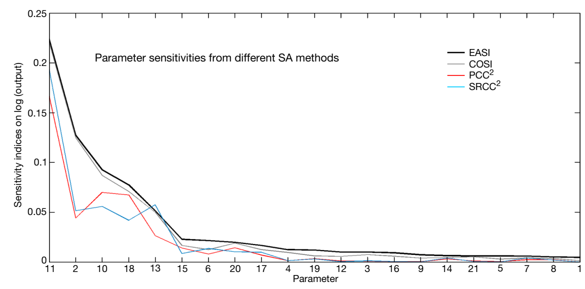


- Convergence reached at considerably lower number of runs with LpTau sampling.
- This also holds for other SA methods.

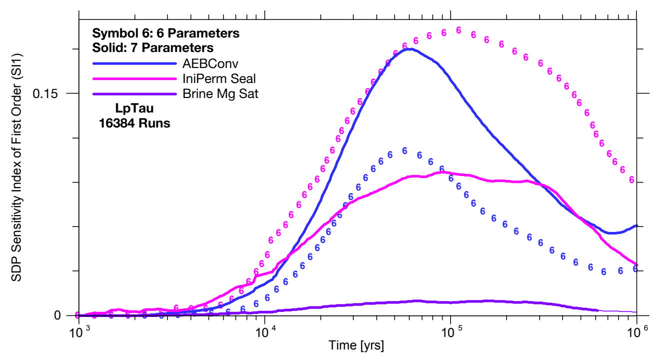
Model B: Repository for LILW in a salt formation

Nonlinearities and quasi-discontinuities





- Different SA methods yield different rankings.
- Linear (rank) regression/correlation methods perform surprisingly well despite the nonlinearity of the model.
- Poor performance of EFAST, possibly due to periodic sampling and quasi-discontinuities.



- Parameter of indirect importance could only be identified by investigating different sets of parameters.

Questions for future work

- Which methods are most appropriate for which types of PA models?
- How to deal with parameter dependencies (correlations)?
- How can the significance of results be improved by application of output transformations?

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