Can history matching mess up my dual-porosity fracture model?

By perturbing upscaled quantities like permeability and heat transfer coefficient, one may create reservoir models that are inconsistent with the underlying fracture model

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Background

Subsurface fracture models are commonly upscaled to a dual-porosity simulation model. Afterwards, the dual-porosity parameters are adjusted until the model matches production data. However, this procedure does not necessarily honor the initial fracture model.

Research questions

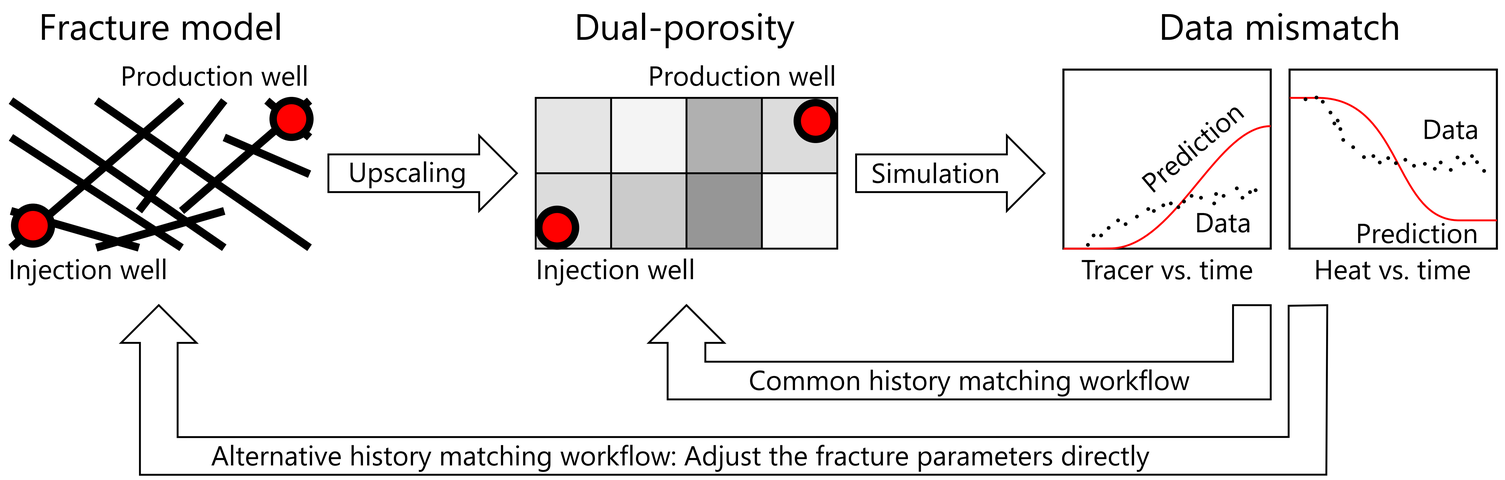
- Can history matching create perturbed simulation models that are inconsistent with the initial fracture model?
- When does this happen, and how can we avoid it?
- What are the consequences of predicting from an inconsistent simulation model?

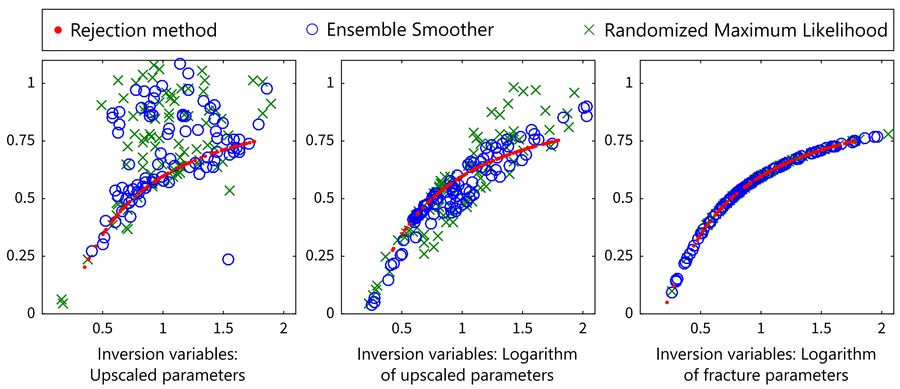
Methods

We compared two approaches to upscaling and history matching: The commonly used workflow, and an alternative workflow (see figure). The alternative approach is, by construction, always consistent with the fracture model. The two workflows were applied to numerical test cases, with varying prior uncertainty, upscaling error, and different choices of inversion variables. Analytical arguments were made to explain the results.

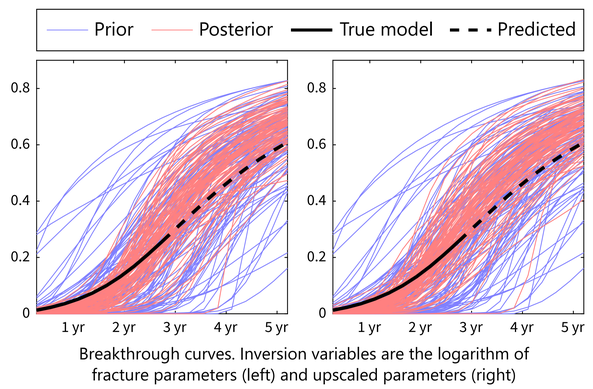
Results

- The two approaches are equivalent if the upscaling step is a linear transformation. This may happen, for instance, if the fractures are fully connected and the logarithm of the parameters are used as inversion variables.
- If the upscaling error is large, the difference between the two approaches may become negligible.
- Two simulation models that are consistent and inconsistent with the initial fracture description, respectively, may have equal predictive power.





Posterior connectivity vs. fracture density



Five spot two-phase test case

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