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Sequential simulation and cross bore hole GPR tomography

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Sequential simulation is a well known geostatistical method for generating realizations of a random field with some a priori chosen basic statistics such as the mean, variance, covariance and/or histogram. All realization will honor the basic statistical assumptions and any observed data observations at specific locations. Recently the theory of sequential simulation has been extended such that realizations can also be conditioned to linear average measurements over the model space. Cross-bore hole tomography measurements are such linear average measurements.

Using data from a cross-borehole Ground Penetrating Radar (GPR) experiment, currently being carried in Northen Sealand Dennark, we will show how to use sequential simulation to draw samples of the a posteriori distribution of a cross bore hole tomography problem.

We will show how we initially choose the a priori covariance model, and how we can validate the covariance model using the observed travel time data. Further, we show how to generate samples of the a posteriori distribution and how this enables us to give probabilistic answers to question like : "What is the probability that the sand layer observed in bore hole A is connected to the sand layer observed in bore hole B". Also, we will comment on the use of realizations in subsequent flow modeling of the downward penetration of fluid, which is the actual goal of the cross bore hole GPR study.

Finally we discuss our claim that the traditional smooth least squares based linear inversion result is not an actual solution to the inverse problem (ie. not a sample of the a posteriori distribution), but the mean of all possible samples of the a posteriori distribution.