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# Constraint-based parameter sampling to leverage expert knowledge for conditioning soil biogeochemical models

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Mechanistic models facilitate understanding complex biogeochemical interactions and process chains in soil. However, biogeochemical soil models often have weakly constraint parameters and show sloppiness. That means the dimensionality of parameter spaces is overly large and parameters often cannot be inferred based on available experimental data. Thus, equifinality arises, i.e. many different parameter combinations lead to very similar or identical model predictions.

Expert knowledge represents a synthesis of existing knowledge on processes in soil systems that can be used to find viable parameter regions such that models give plausible predictions in line with evidence-based expectations. Here, we present an approach to leverage expert knowledge. This is achieved by formulating expert knowledge in terms of parameter and process constraints that must be fulfilled. Viable parameter sets are then identified by model conditioning using a novel Bayesian constraint-based parameter search algorithm that extends a previously published iterative constraint-based parameter search method. The algorithm successively applies stricter conditions by increasing the minimum acceptable number of process constraints to be satisfied in each iteration.

We present the concept of the algorithm and demonstrate a successful application to a complex model simulating biodegradation of the herbicide Atrazine that has a high-dimensional parameter space. The presented approach can be widely applied to other soil biogeochemical models and provides a powerful tool to leverage expert knowledge for constructing robust prior parameter distributions for model sensitivity analysis or calibration.