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Improving the Use of Data for Quantifying Uncertainty in Parameters and Predictions of Forest Dynamic Models by Bayesian Approach

Alexander Komarov

Pavel Grabarnik

Alexey Mikhaylov

Oleg Chertov

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Alexander Komarov, Pavel Grabarnik, Alexey Mikhaylov, Oleg Chertov
Institute of Problems in Soil Science, Pushchino, Russia.
as_komarov@rambler.ru

Abstract: Ecological models may include components which are stochastic: climatic parameters, spatial structure and so on. Therefore, the model outputs possess inevitable uncertainties. Moreover, the output uncertainty depends on variability and/or uncertainty of parameters and initial values. Uncertainty analysis which studies how input variability influences a variability of output is an important part of a model building allowing separating different sources of uncertainties. Another task, which is associated with highly structured multiparameterized model is sensitivity analysis, goal of which is to characterize how the model outputs respond to changes in the inputs. Both uncertainty and sensitivity analysis can be conducted by means of the Monte Carlo procedure. To use a model in specific context it may be necessary to calibrate the model by using some observed data. Calibration is a reduction of uncertainty of input parameters and it is a key stage of a model building. An effective approach based on Bayesian estimation was proposed recently [1,2] allowing one to incorporate a prior knowledge of parameter variability. There is a certain difficulty when applying the Bayesian calibration for parameters of highly complicate models, which is a case of spatially explicit individual-based models [3]. For such models the likelihood, connecting data (output) and parameters (input) in probabilistic form, is either impossible or computationally prohibitive to obtain. Recently, there was proposed a Markov chain Monte Carlo method for generating samples from a posterior distribution without the use of the likelihood [4]. We discuss uncertainty and sensitive analysis and Bayesian calibration issues by example of a model of growth and cycling of elements in boreal forest ecosystems EFIMOD [3].

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