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Bayesian update of hydrogeological model parameters making use of calibrated groundwater flow models

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Hydrogeological models describe the subsurface in a hydrological and geological context. These models usually serve as input for applications like groundwater flow models. Since models always are subject to errors, groundwater flow models are calibrated by using additional data. In the Netherlands, a multipurpose hydrogeological model (Regis) is developed and maintained. This model serves as a source to derive dedicated hydrogeological models for multiple different groundwater flow models. When a groundwater flow model is calibrated, this only affects the dedicated hydrogeological model and not the Regis model. We developed a method to convey the new information of the calibrated groundwater models back to the original Regis model.
In a Bayesian inference, the aim is to make an update of the prior uncertain parameters, preferably decreasing the uncertainty, by using observations. Therefore, the parameters (hydraulic conductivity and layer thickness) of the Regis model are described as uncertain data with appropriate probability density functions (PDF), which are the prior distributions in a Bayesian context. The joint PDF of these uncertain data is described by a Bayesian Network (or a Directed Acyclic Graph). The calibrated parameter values of the groundwater flow models are used as observations to arrive at posterior distributions of the Regis parameters. This method is implemented with piecewise linear approximations of the PDFs, which makes the method very flexible in the choice of probability distributions. An example of a real world case is presented.