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Application of a generalized likelihood function for parameter inference of a carbon balance model using multiple, joint constraints

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Advances in automated data collection systems enabled ecologists to collect enormous amounts of varied data. Data assimilation (or data model synthesis) is one way to make sense of this mass of data. Given a process model designed to learn about ecological processes these data can be integrated within a statistical framework for data interpretation and extrapolation. Results of such a data assimilation framework clearly depend on the information content of the observed data, on the associated uncertainties (data uncertainties, model structural uncertainties and parameter uncertainties) and underlying assumptions.
Parameter estimation is usually done by minimizing a simple least squares objective function with respect to the model parameters – presuming Gaussian, independent and homoscedastic errors (formal approach). Recent contributions to the (ecological) literature, however, have questioned the validity of this approach when confronted with significant errors and uncertainty in the model forcing (inputs) and model structure. Very often residual errors are non-Gaussian, correlated and heteroscedastic. Thus these error sources have to be considered and residual-errors have to be described in a statistically correct fashion order to draw statistically sound conclusions about parameter- and model predictive-uncertainties.
We examined the effects of a generalized likelihood (GL) function on the parameter estimation of a carbon balance model. Compared with the formal approach, the GL function allows for correlation, non-stationarity and non-normality of model residuals. Carbon model parameters have been constrained using three different datasets, each of them modelled by its own GL function. As shown in literature the use of different datasets for parameter estimation reduces the uncertainty in model parameters and model predictions and does allow for a better quantification and for more insights into model processes.