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Multiple constraints in inverse problems: The importance of model discrepancy

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In model-data integration it is important to acknowledge model discrepancy, the difference between the process underlying the observations and the prediction of a calibrated model. This becomes especially important when using multiple data streams that strongly differ in their number of records.

By using a basic example we illustrate that without precautions, posterior uncertainty is underestimated and parameters are adjusted so that model predictions match the richest data stream, i.e the stream with most records. Model discrepancy is preferentially allocated to sparse data streams. This impedes both, the inference about the model parameters, and the identification of process formulations that need to be improved.

Here we show that explicitly modelling discrepancies by Gaussian processes (GP) is a natural approach of penalizing those discrepancies in a balanced way across imbalanced data streams. The GP-approach correctly attributed the discrepancy to the rich data stream in a basic example.

We present an model-data-integration of the DALEC terrestrial biogeochemical model with 10 year of observations of NEE, respiration and litter fall at the Howland forest site. The GP approach balances model discrepancy across multiple data streams. Its allows improved inference on model parameters and model processes.