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Can high-frequency data enable better parameterization of water quality models and disentangling of DO processes?

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Water quality models offer to study dissolved oxygen (DO) dynamics and resulting DO balances. However, the infrequent temporal resolution of measurement data commonly limits the reliability of disentangling and quantifying instream DO process fluxes using models. These limitations of the temporal data resolution can result in the equifinality of model parameter sets. In this study, we aim to quantify the effect of the combination of emerging high-frequency monitoring techniques and water quality modelling for 1) improving the estimation of the model parameters and 2) reducing the forward uncertainty of the continuous quantification of instream DO balance pathways.

To this end, synthetic measurements for calibration with a given series of frequencies are used to estimate the model parameters of a conceptual water quality model of an agricultural river in Germany. The frequencies vary from the 15-min interval, daily, weekly, to monthly. A Bayesian inference approach using the DREAM algorithm is adopted to perform the uncertainty analysis of DO simulation. Furthermore, the propagated uncertainties in daily fluxes of different DO processes, including reaeration, phytoplankton metabolism, benthic algae metabolism, nitrification, and organic matter deoxygenation, are quantified.

We hypothesize that the uncertainty will be larger when the measurement frequency of calibrated data was limited. We also expect that the high-frequency measurements significantly reduce the uncertainty of flux estimations of different DO balance components. This study highlights the critical role of high-frequency data supporting model parameter estimation and its significant value in disentangling DO processes.